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SEPTEMBER • 1949

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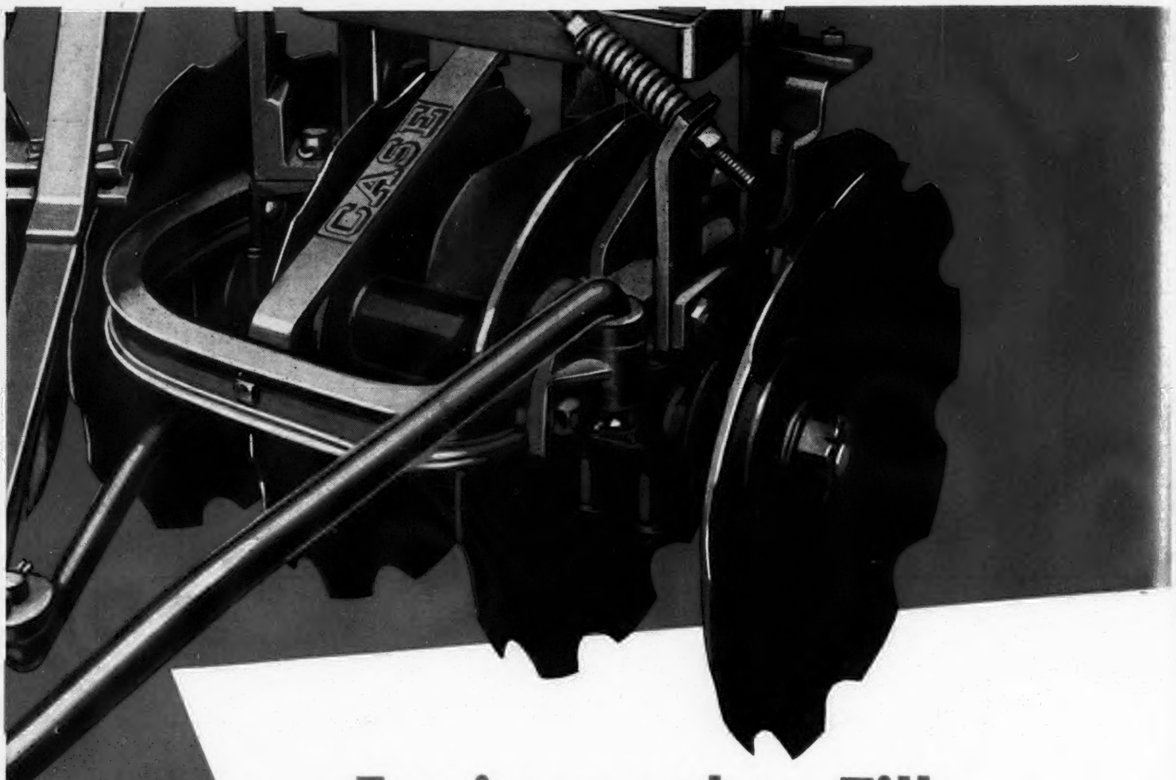
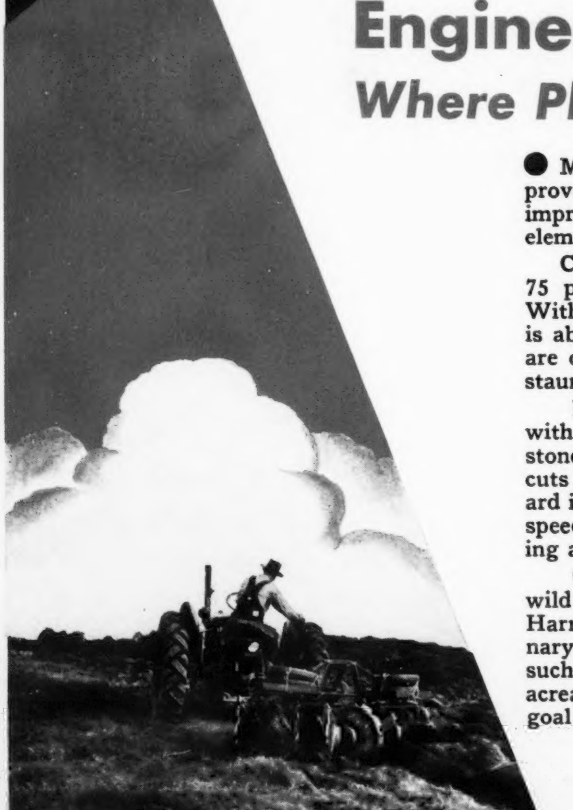


Engineered to Till
Where Plows Won't Work



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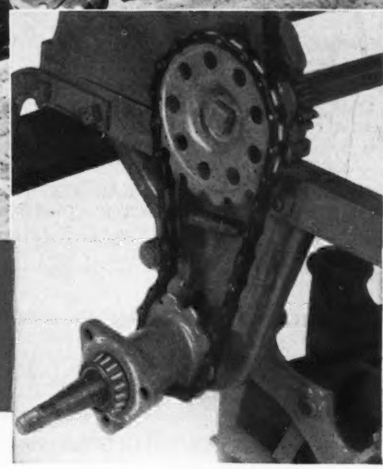

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AGRICULTURAL ENGINEERING

Established 1920

CONTENTS FOR SEPTEMBER, 1949

Vol. 30, No. 9

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EDITORIAL

Effects of Mechanization

A RECENTLY reported sociological study of "Effects of Mechanization on American Agriculture"* provides some corroborative evidence and sidelights on results of the work of agricultural engineers.

Number of tractors per 100 farms was taken as a practical index to degree of mechanization, for purposes of this statistical study. It provided a convenient way of classifying areas for a comparison of possible cause and effect relationships. It may prove a suitable index for use in other similar studies. Changes during the period from 1920 to 1945 are given most attention.

It seems significant that the author points to heavy losses of croppers and laborers, due to crop adjustment programs, droughts, and alternative employment opportunities, as a contributing cause rather than effect of increasing mechanization. In some writings seeking to make a case against farm mechanization, it has been cast as the villainous cause of people leaving the farm.

Whether as a cause or an effect, for better or worse, the report indicates the following conditions associated with highly mechanized farming areas, as compared with areas in which farm mechanization has made least progress:

Greater decreases in total farm population and in rural non-farm population.

Decreasing numbers of children and persons in the younger working ages, and increasing proportions of total population in the older ages.

"It is conceivable that mechanization, by easing the labor of farming, will lead to a longer earning life among agriculturists. On the other hand, it might enable farmers to retire at earlier ages than in the past."

Fewer farmers were employed in work off the farm in 1944 than in 1934, the decrease being greatest in the states with greatest mechanization. At the same time the number of farmers working more than 100 days per year off their farms increased, but the increase was much less in the highly mechanized areas. This reflects a relationship between mechanization and the income-producing capacity of farms.

Farm wage laborers have decreased notably. This might be interpreted as further evidence that mechanization is helping the family farm to survive as an economically sound and socially desirable institution.

A possible stabilizing influence not commonly brought out in similar studies is suggested by the point that "changes in farm ownership and tenancy appear to be retarded by farm mechanization." This may or may not be desirable. No indication is given as to whether mechanization makes the status quo more desirable or more difficult to change.

On the other hand, Dr. McMillan points out that "census data fail to support the popular belief that farms operated by non-residents are increasing more rapidly in the states with the most mechanization."

While total acreages of farms were increasing between 1920 and 1945, most noticeably in the highly mechanized states, their acreages in crops were decreasing the smallest amount. Cultivable land has been devoted to an increasing extent to those crops for which production methods have been most highly mechanized.

Mechanization increased the proportion of farm products sold for cash, and decreased traditional farm self-sufficiency and autonomy.

While farm labor costs increased notably between 1924 and 1944, largely due to factors beyond the control of the individual farmer, they did not increase nearly as much for the highly mechanized farmers.

"Adequate capital resources are a prerequisite of mechanization."

"There is a very definitely vertical concentration of wealth and income associated with farm mechanization."

Value of land and buildings on farms over 500 acres increased, and most in highly mechanized areas.

Number of farms with gross production of over $6000 per year increased 231 per cent 1929-44, in states with most mechanization, considerably more than in the less mechanized areas.

Important decreases in the horse and mule population in states where farming is most highly mechanized have been practically offset by increases in numbers of beef cattle, milk cows, and sheep, according to the report.

"The level of living of farm operators families correlates closely with amount of farm mechanization." However, it did not increase in proportion to mechanization between 1920 and 1945, possibly due to increased income being used to pay off debts and accumulate the capital which mechanization requires, and to the higher cash costs of mechanized farming which may reduce the proportion of gross income available for family living.

"Farm families probably have more time for participation in leisure, religious and other social activities as a result of mechanization." A noted result is an increase in consolidation and a townward movement of schools, churches, and recreational facilities. An indicated probable further result is that farm people "will become more urbanized in attitudes and behavior."

While we have no serious quarrel with the conclusions drawn by Dr. McMillan, our own would emphasize some different points.

The history of civilization is one of accumulating, developing, and using capital aids to the human work of bare hands and strong backs.

Recent and continuing achievements of farmers, agricultural engineers, and the farm equipment industry in the mechanization of agriculture represent an overdue increase in application of the capital-aid principle to a basic phase of our civilization.

* Effects of Mechanization on American Agriculture," by Robert T. McMillan, in "Scientific Monthly," July, 1949.

Engineering Frontiers

IN THE words of a chemical engineer† we have found apt expression of the engineering viewpoint which has fostered and accepted agricultural engineering, which has given it recruits, and which can carry it on to increasing usefulness.

> "The primary engineers are those who are engaged in applying the results of science to the practical ends of man, but there are many who may be called secondary, i.e., those who are applying engineering training and techniques to all of the varied problems of life. You will find even in our engineering societies many who will not credit the secondary group with being engineers at all. . . . From the original kernel of design engineering the profession has gone on to control the processes of production, of research, of sales, and finally of management. While this is particularly true of the chemical and other strictly technical industries, there are still further fields for the engineer to conquer in those industries not usually considered technical, where his training and logical thinking in the analysis of problems and in the synthesis of decisions will prove of supreme value, if to them he can add vision. We must look outward and not inward.
>
> ". . . . Man must have a stimulus, some form of insecurity, not necessarily financial, to continue to drive him on to attainment.
>
> "The engineer is no exception to this rule. If he is full of supreme confidence in himself and what he has learned, if he does not constantly seek to enlarge the boundaries of his profession into fields not yet belonging to it, he is already building an enclosing armor. He must be able to recognize forms and practices of engineers not of the original, conventional, primitive kind."

Who better than engineers should see in man, his environment, and his activities, the materials, forms, energies, mechanisms, reactions, principles, and quantitative relationships potentially subject to effective mastery by engineering techniques? Who better than engineers should appreciate the limitations of engineering techniques *(Continued on page 438)*

† "Human Values in Engineering," by Francis J. Curtis, president, American Institute of Chemical Engineers, in the "Engineering Experiment Station News," Ohio State University (Columbus), June, 1949.

A "Caterpillar" Diesel No. 112 Motor Grader building a Nichols-type terrace entirely from upper side, near Dadeville, Alabama.

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AGRICULTURAL ENGINEERING

VOL. 30 SEPTEMBER, 1949 No. 9

Adventures in Understanding—The Engineer as a Citizen

By Leonard J. Fletcher
FELLOW A.S.A.E.

AS ENGINEERS, I know exactly how you tend to shy away from any non-technical subject. "Let's stick to our knitting", you say. "Let those whose specialty it is deal with these other problems." But the social changes now under way in the world must be of real concern to every engineer. We in this country have been privileged to live in an economy, and under a form of government, that has allowed maximum utilization of engineering skills and techniques. Our way of life, however, is being threatened — not so much from outside or from "above", as from the misunderstandings now increasing between the people of this land.

During the last 2,000 years less than 5 per cent of the people of the world have lived in freedom; have been free to act under fairly administered laws insuring their rights and the rights of others; free to use their ability to serve others where and how they wished; free to receive compensation in proportion to the value which others placed upon their services.

Following World War I the countries of the earth were visited by the dread epidemic of influenza. After World War II another universal disease appeared which might well be called "groupitis" — people dividing into increasingly smaller groups of increasingly higher degrees of specialized interests. Many of these groups, almost unknowingly, set up new ways to play "take away." Here suspicion and doubt grows concerning the services of other groups, and the walls between us thicken. The principal sport of each group is dodging facts and cultivating opinions and prejudices. At times groups combine to follow that leader who can sing, in the sweetest voice, "Oh, Promise Me".

Much of this misunderstanding has arisen over the operation of our system of private capitalism. The engineer has a real stake in the institution of capitalism. It is only through the accumulation and wise use of savings, or what truly can be called "preserved labor", that many of the ideas born in the minds of engineers become tangible accomplishments and of service to mankind. Under capitalism the engineering profession has developed and advanced. Society has been *allowed* to utilize the materials and forces of nature.

This is an address delivered at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949.

Leonard J. Fletcher is director of training and community relations, Caterpillar Tractor Co., Peoria, Ill. He is a past-president of ASAE (1931-32), and was awarded the Cyrus Hall McCormick Gold Medal in 1944.

Our way of life (in America), says Mr. Fletcher, will continue only if we are able to develop clearly in the minds of the great majority of our people the *understanding* as to why their desires for more and better things can be reached only through their own increased efficiency in production and distributors

The Indians who previously occupied what is now the United States of America had access to all of the natural resources which we utilize. The Indians were ingenious. They had the ability to withstand for many years the armed men from overseas. Yet the Indians were few in number and lived mainly under the shadow of famine and epidemic. They had not discovered, or did not utilize, the institution of individually owned property or of capitalism.

In general, people living under totalitarian rule of czars and dictators tend to copy the efforts of the free peoples of the world. There is generated within these subject people great desires for their own developments, which leads to their government's indulging in the "massacre of the truth." We witness daily the grotesque sabotage of the true history of invention and science as presented to the people of the U.S.S.R. Strangely enough, this disease, often called "collectivism," is spreading and threatens the progress of the world. Unless the people of free countries today each individually do their share to develop understanding, a new Dark Age of social disintegration is surely on its way.

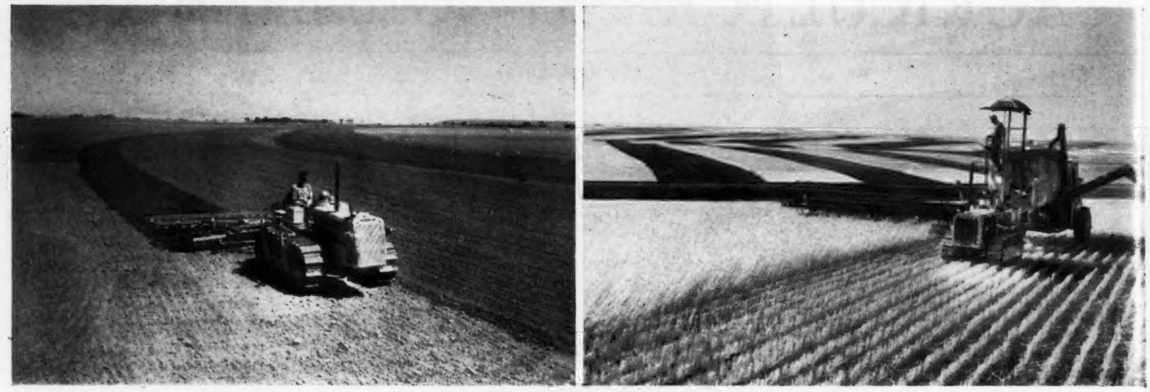
In 1857 the noted historian, Macaulay, wrote from his home in Kensington, London, to his friend Randall in the United States. Following are three excerpts from his letter:

"I have long been convinced that institutions purely democratic must, sooner or later, destroy liberty or civilization or both."

"Either the poor would plunder the rich and civilization would perish, or order and prosperity would be saved by a strong military government, and liberty would perish".

"I seriously apprehend that you will, in some such season of adversity as I have described, do things which will prevent prosperity from returning; that you will act like people who should in a year of scarcity devour all the seed corn, and thus make the next a year, not of scarcity, but of absolute famine. There will be, I fear, spoilation. The spoilation will increase the distress. The distress will produce fresh spoilation. There is nothing to stop you. Your Constitution is all sail and no anchor. As I have said before, when a society has entered on this downward progress, either liberty or civilization must perish. Either some Caesar or Napoleon will seize the reins of government with a strong hand, or your Republic will be as fearfully plundered and laid waste by barbarians in the 20th century as the Roman Empire was in the fifth, with this difference that the Huns and the Vandals who ravaged tht Roman Empire came from without, and that your Huns and Vandals will have been engendered within your own country by your own institutions."

While we may not now agree fully with these comments, they should arouse some real thinking.



The mechanization of agriculture in America has released millions of farm workers for better paid jobs in the mass production and service industries

We hear much today of the atom bomb. We fear its mysterious power. Since the beginning of human society, however, the world has encountered another force far more powerful than the splitting atom. It is the force of human thought. Where this force is loosened through misunderstanding, another type of fatal chain reaction takes place. It starts through lack of acquaintance caused from forming of groups; it proceeds to doubt, to suspicion and envy, then to fear and hatred, and finally to destruction.

The engineer deals with forces, but in general has only recently even considered the force of thought. This force is unruly; it fits no formula; it is difficult to predict. But as we *think today*, we *act tomorrow*. Strangely enough, in the realm of human relations, what we *think* and what we *say* are frequently unrelated. We largely control our speech. We do not "control" our thinking. On the other hand, our thinking is greatly influenced by three factors:

1 We believe the things we want to believe

2 We judge all situations by how they affect us

3 We strenuously avoid taking responsibility for our own shortcomings.

An example of the first of these factors is the generally accepted belief that technical developments employed by our mass production industries have displaced the skilled worker of earlier days. Look on page 187 of the report of the 16th census published by the U. S. Bureau of the Census in 1943. There, in a single table, is complete denial of this belief. There it is shown that during the 30 years between 1910 and 1940 the number of skilled workers in the total labor force increased by two million, the number of semiskilled workers increased five million, while the number of unskilled workers increased not at all — 13 million in 1910, 13 million in 1940. Those engaged as clerks and in other similar employment increased by five million, the number of professional people increased by two million, and the number of farmers and farm laborers decreased by three million. In other words, the machines employed in our mass production industries did *not* destroy the jobs of the skilled workers, but rather lifted tasks from the toiling backs of the unskilled workers, replacing them with the machine-powered jobs directed by the semiskilled. True, these facts are buried in the statistics, but the engineer should be interested in doing a little "mining" in other places than the ground.

Or, again, it is perfectly normal for any individual to want to receive more for his work. He wants to believe those who tell him that his wages can be greatly increased, yet the prices of things he buys decreased — the slack to be taken up from the "great profits" earned and accumulated always by the large industries. Each of us is continually staging a debate in our own thinking between our opinions, desires, and hopes on the one hand, and our realization of the facts or actualities of life, on the other. Most people prefer to harbor these beliefs concerning wages and prices rather than to spend time digging into uninteresting tables. We carefully protect our opinions against disproof. The U. S. Department of Commerce publications show that in the distribution of national income, less than 10 per cent is paid out in the forms of dividends, interest, and rent — in other words, payment for the use of capital or savings — with practically all of the remainder going for wages and salaries, or to the private enterprisers, such as farmers, doctors, lawyers.

Read the well-documented bulletin titled "The National Income and Its Distribution" by Rev. Edward A. Keller, director of the bureau of economic research of the University of Notre Dame. Following is a quotation from this bulletin:

"In 1917, the rich, that is, Americans with a personal annual income of $25,000 or more, were getting 7 per cent of the nation's entire income (after federal taxes). By 1928 their share had risen to 11 per cent. But in the latest available year, 1944, it is down to 1 per cent.

"Lest this be considered a statistical illusion, done with percentages, consider the actual amounts. In 1928, it was close to 9 billion dollars; in 1944, less than 2 billion.

"On the other hand, Americans making under $5,000 a year have been unmistakably increasing their share of the nation's income. In 1917 this group (to which most of us belong) was getting 87 per cent of the total U. S. personal income. By the year 1929, this had dropped to 77 per cent. But in 1944, it reached the peak figure of 90 per cent. This increase of 3 per cent in 27 years doesn't tell the whole story. Look at the volume: In 1917, 47 billion dollars; in 1944, 140 billion dollars . . . a gain in one generation of almost another hundred billion dollars for the 'poor'.

"Meanwhile an interesting thing has been happening to the middle group, the people whose annual income is over $5,000 but under $25,000. They have progressed from a low of 6 per cent of the nation's income in 1917 to a high of 12 per cent just before the depression set in, to nine per cent in 1944. And their volume is up from 3 billion dollars in 1917 to 13 billions in 1944.

"These facts completely discredit the common belief that a few wealthy individuals receive most of the national income, while the majority of the people receive the minor share. This, the legend continues, leaves insufficient purchasing power in the hands of the majority of consumers, with the result that they are unable to buy the goods and services they have produced. And this in turn, is supposed to be the main cause of depressions.

"But if, as stated before, the spendable income of the wealthy class in 1944 was 2 billion dollars, and consumer expenditures in that year amounted to 90 billion dollars, it is obvious that the 2 billions of the well-heeled could hardly account for the purchase of 90 billions of goods and services.

"A little common-sense observation would quickly disclose that the vast amounts of goods and services cannot be consumed by a few wealthy people.

"The figures reveal some other interesting facts about this wealthy class. For instance, those with incomes above $25,000 are largely a workers' class, since 67.5 per cent of their total income was in payment for personal labor. And what huge proportion of the total U. S. income from interest, dividends, and rent would you guess this wealthy class to have received? Three and one-half (3½) per cent.

"Since 1929, labor has received an increasing share of the national income, while the owners (mostly other workers) of the 'tools' (machinery, plants, etc.) have received a declining share of total national income.

"While national income increased 93 per cent from 1929 to

1946, labor payments rose 110 per cent, and wages and salaries rose 107 per cent. But corporate dividends during the same period not only made no gain, they actually fell by 14 per cent. This decrease was speeded up during the war by increased taxes, rent ceilings, and declining interest rates.

"From 1929 to 1945 practically all of the increase in national income went to workers in increased labor payments. Furthermore, in 1929 labor payments accounted for 82 per cent of income paid out; in 1945 they accounted for 90 per cent.

"This is important because, taking our economy as a whole, it shows that the main item of cost of production of all goods and services is labor cost (90 per cent), while cost for the use of tools is a relatively minor cost (6 per cent)."

Those who might wish to show the hard life of many of our farming people can find "facts" to uphold this belief in our agricultural census. In the 1945 census for Peoria County, Illinois, table 3 indicates that 253 farmers in this county each produced farm products valued at less than $400. From this many people draw the conclusion that over 200 farmers in this county are somehow managing to live on incomes of less than $400 a year. In table 1 of the same report, however, there is neatly buried the fact that 271 farmers in this county worked over 250 days each *"off from their farms"*. Here are 50 five-day weeks. "How can this be? you ask. Not printed in this report, but in a more complete description of the census, there is an explanation of what is called a farm or a farm operator. Farms in past censuses include any area capable of producing any kind of crop, three acres or more in area. It is rather amusing to see a footnote under table 3, which is headed "Farms Classified by Total Value of Farm Products", that reads.: "This table includes farms with no farm products sold or used". In other words, to gain a true picture of how we live in this country calls for a bit of diving below the surface.

The virus of the disease "groupitis" is carried in every message of those who proclaim the doctrine of "Something for nothing — it's right to take away from others", who paint in rosy hues the pictures of "the land of the free lunch". This disease will be checked only through the application of truth and honesty.

DIFFICULT TO MISLEAD PEOPLE 100 YEARS AGO

In the simple economy of a hundred years ago, it was difficult to mislead people concerning their economic existence. People saw most of the necessities of life actually produced in their own villages and on the farms. They thought of cost in terms of hours of labor, rather than dollars and cents. Even the philosophy of Karl Marx voiced a hundred years ago could gain little headway until our economy became more complex, and people were more easily misled. Marx made many mistakes in his analysis of the then budding industrial system. He could not visualize the time when workmen could possibly buy with their wages the products of their own production. Neither could he visualize the implementation of a Christian conscience or philosophy whereby men would assume responsibility for their needy brethren. Marx created a perfect "devil" on whom to blame our own predicaments and shortcomings, namely, the "capitalists".

The extent to which misunderstanding has spread into the speaking and writing of this age is clearly evident when members of the clergy visit our plant. When asked what they would like to see, many of these men desire to visit our assembly lines. When they first arrive at this part of the plant and take a quick look, some voice regret that the line is not running. When their attention is called to the slowly moving line, and they are informed that this is the regular work pace, they occasionally indicate amazement that they do not see men, stripped to the waist, racing frantically along the line trying to get that last turn on the fleeting nut. We think with pictures, not words. But the "words" concerning mass production read by many people produce pictures quite unlike reality.

The cure for "groupitis" is evident. It is understanding. This understanding can best be developed in those areas where each of us live — in our own communities. Here we develop our acquaintanceships which ripen into friendship. Here are the people we meet day after day, with whom we exchange viewpoints — swap ideas. Here we can, with little effort, organize discussion groups where people from many walks of life can come together and learn how each serves the others. This is the place to bring out the facts as previously stated concerning the service of the machine. We can explain how much it costs to provide each job in our factories, and where this money comes from. We can point out that no one wishes to work for a company that is going broke — which is another way of saying that profits are just as much, or even more, of a service to the employee as a means of job insurance as they are to the investor as a source of dividends. We can point out that corporations do not "pay" but rather "collect" taxes — that taxes are really paid only by individuals who cannot pass them on to others.

We will find in these meetings with others that it is fun to make friends in new areas; that friendship is not based upon complete agreement in social viewpoints, but rather that friendship is based on mutual desires for the truth, upon intellectual honesty, upon such fundamentals as morals, integrity, and character.

Occasionally, engineers learning that I have devoted several years of my life in the Soviet Union remark that they are not too much concerned about the type of society in which we work, since even in the Soviet Union the service of engineers is highly essential. How little these men understand the plight of the engineer working in a planned economy. Here a small group of determined but poorly informed men, not interested in details, prepare fantastic and grotesque plans and pass them down the line, each bearing its own "must" date. Eventually these plans reach some hapless engineer who is charged with the responsibility for producing a design, a production schedule, a crop, or buildings. For a few brief months this engineer, while in charge, may receive the best that the land affords (which isn't much), but every waking moment this engineer is looking down the road at the sign which reads, "No Results — No Engineer"! No country has ever given such great opportunities to the engineer as the United States of America.

You as a professional man, as an engineer, must assume a wider leadership as a citizen of this country. We are a society of people who work. We support no leisure class. But our freedom is imperiled now. Our way of life will continue only if we are able to develop clearly in the minds of the great majority of the people of this nation the *understanding* as to why their desires for more and better things can be reached only through their own increased efficiency in production and distribution. In addition, there must likewise be real understanding of how honest and vital a place in our life is the investment of earnings of individuals — and the creation of profits. Building confidence in the integrity of our fellowmen is our No. 1 job. Each of you can accomplish most in your own home community where you are known as individuals, where you can learn for yourself the joy of taking part in your own "adventure in understanding."

Agricultural Engineering in the Americas

A NOTABLE contribution to the First Pan American Engineering Congress, held at Rio De Janeiro in July, was a paper on "Mechanization of Agriculture with Special Application to Latin America," by Arthur W. Turner, a past-president of American Society of Agricultural Engineers and in charge of agricultural engineering research (BPISAE), U. S. Department of Agriculture. The picture he presented is one generally familiar to agricultural engineers.

Its special value lies in the fact that it marked the acceptance of an invitation to present the case for agricultural engineering to a select audience of engineering leaders in the Americas. And in doing so it put on record another strong but accurate representation of the nature and importance of agricultural engineering, where it will continue to contribute to understanding and good will in the engineering profession.

It is desirable that agricultural engineers continue to take every opportunity to clarify for leaders in other fields the nature and importance, the requirements and opportunities for humanitarian service in the application of engineering in agriculture.

Machinery for the Conservation Farmer

By J. C. Dykes
MEMBER A.S.A.E.

WHEN I was extended an invitation to participate in our annual meeting program this year, it seemed to me to be an appropriate occasion to do three things:

1 Emphasize one of the most important tasks facing this country today — the task of developing 5,800,000 conservation farmers and ranchers, one to operate each of our farm and ranch units. In the past we have been prone to describe the conservation job ahead in purely physical terms — the miles of terraces to be built, the acres of land to be leveled for irrigation, the number of acres to be contour-tilled, etc. Yet we have always said that the primary responsibility for achieving soil and water conservation rests with the owners and operators of the land. If the job is to be done and is to stay done, we need to direct our attention to the people who will do it and who will maintain it. The physical tasks remain but we need to give added assistance in changing the ways of thinking of the nation and particularly of those who own and operate the land.

2 Give credit where credit is due.

3 Ask some questions which it is hoped will receive your earnest consideration.

To lay a proper foundation on which to build a discussion of machinery for the conservation farmer, it will be well to discuss briefly "conservation farming" and to define the term "conservation farmer."

Conservation farming results from using each acre in accordance with its capabilities (or less intensively) and from treating each acre in accordance with its need. This type of farming is profitable almost immediately as has been thoroughly demonstrated in all parts of the country by thousands of farmers, and it offers the added advantage of permanently protecting the productive capacity of the nation's agricultural plant. The farmers who farm the conservation way may or may not be "conservation farmers." Some farm the conservation way because it makes them more money. Some because their neighbors farm that way. Some because they are ashamed not to. In time, and with all of us helping, most of them will become "conservation farmers", for "conservation farmers" are not born that way — they develop.

Remember the word is "developing" — not "educating" — not "training." "Developing" as used here means the logical, step by step evolution of a farmer into a "conservation farmer." I will give a simple example of my first conscious experience with a "conservation farmer."

Kenny is a supervisor in his home district in Illinois. I got acquainted with him just a little more than two years ago when I accepted an invitation from his board of supervisors to attend their annual district tour and dinner. The supervisors in that district prefer small tours and invite only a relatively few people each year. This particular year their guests were the farm loan agents of the banks in the district, of the big insurance companies, of the Farm Credit Administration, and so on — in short, the people who were responsible for loans on farm land in the district. The tour was short — it covered only Kenny's land. We drove over his farm in cars, using his contour meadow strips and his permanent grass waterways as roads. His corn was in strips on the contour and the strips of rows wound around the rolling lands in anything but the historical straight-row fashion.

One insurance farm loan agent took quite a little kidding from his brethren because he failed to recognize Kenny's farm as one on which he had formerly made a loan. He said it didn't look like the same farm to him and at the dinner that night the brethren agreed with him that it wasn't the same farm although the legal description remained the same. But at one of the stops that afternoon, this loan agent who had failed to recognize his old collateral asked Kenny a question. As I recall it was stated about like this: "Kenny, how do you like farming these crooked rows compared with straight-row farming?"

The question may have been asked to divert the attention of those kidding him and only half in earnest, but Kenny's reply was in all seriousness. He said: "I'm afraid you've asked the wrong fellow. Of course, I remember, as a boy, trying to plow straight rows back home on Dad's farm, but since 1935, when I started farming for myself, I've always farmed the conservation way, on the contour, or with these crooked rows as you call them. I just can't answer your question."

I am pretty well convinced that Kenny was a conservation farmer back in 1946. He will continue to be one because that is the only kind of farming he knows. No matter where he farms, it will be the conservation way because it has become part of him. His eleven years of experience farming the conservation way far outweigh his boyhood efforts to plow a straight row. His own experience and those of his neighbors and the exchange of information between them, his leadership in conservation affairs in his own neighborhood, and finally his position of responsibility as a district supervisor resulted in Kenny's developing into a conservation farmer.

To me then a conservation farmer is one who, like Kenny, has step by step forsaken permanently all other ways of farming, knows only the conservation way, therefore can farm no other way. It is in his heart, in the love of the land, and in his mind as the only logical, reasonable way of conserving, utilizing, and improving the good earth while making it financially profitable to himself.

Conservation farmers develop through logical step by step growth. It usually takes place in about this way:

1 A farmer decides to cooperate with his soil conservation district and files an application for district assistance.

2 He learns about the capabilities of the various kinds of land on his farm and the needs of the various fields from a technician sent him by the district governing body.

3 He develops a conservation plan for his farm assisted by a technician or technicians thoroughly trained in the alternatives of land use and treatment in that local area.

4 He applies the conservation plan to his farm assisted by technicians with those practices and measures with which he needs help, utilizing his own power, equipment, and labor in so far as possible. He contracts the heavy earth-moving jobs that he cannot do with his own equipment.

5 He completes the equipping of the farm with the necessary power units and implements to do his own particular kind of conservation farming.

6 He maintains the conservation practices and measures he has installed and from time to time makes improvements in his conservation program.

7 He discusses his conservation plan with his neighbors, and compares his with theirs. Analyzes his successes and his failures with his neighbors. Profits by their mistakes. Borrows equipment he doesn't have. Lends to his less fortunate neighbors. Exchanges labor and ideas with his neighbors. Participates in neighborhood conservation projects. Pools his resources with his neighbors for the purchase of needed equipment. Shares his experiences in conservation farming with his neighbors and shares theirs.

8 He practices conservation farming for a period of years.

9 He finds conservation farming rewarding from the financial standpoint, as well as heart satisfying in knowing that he is preserving the heritage of his children and his children's children.

This is an address delivered at the annual meeting of the American Society of Agricultural Engineers held at East Lansing, Mich., June, 1949.

J. C. DYKES is assistant chief, Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C.

Boys who grow up on such farms learn conservation farming in the most natural way. They have no bad farming habits to forget and will nearly always farm the conservation way as soon as they become operators, managers, or owners. The real problem then lies with the present owners and operators and with those who follow them who have not had the privilege of growing up on conservation farms.

It seems very clear that many people, many agencies, and many institutions have an opportunity to assist the farmer in developing into a conservation farmer. The educational agencies, particularly the extension service and the vocational-agriculture teachers, have the responsibility of providing the information on which primary (step 1) and many other decisions should be based.

The farmer's own soil conservation district has a major role. The district is the focal point of local conservation activities. Nearly 2200 of them have been organized under state and territorial enabling legislation, and over 80 per cent of the farmers and ranchers in this country live within their boundaries. Each of these districts is governed by a board of five farmers elected by the farmers living in the district and under the leadership of the district governing body; a locally adapted program and work plan is developed for the lands within the district. Through the district the cooperating farmers, on an entirely voluntary basis, seek and receive assistance from the local, state, and federal agencies which have agreed to help the district carry out its adapted work plan.

The personnel of my agency — the Soil Conservation Service — assigned to assist districts have a vital role in development steps, 2, 3, 4 and 6.

The local farm equipment dealers, with necessary backing from the equipment manufacturers, have important contributions to make in a number of the development steps.

The neighbors of a farmer who starts toward the goal of becoming a conservation farmer can materially influence his progress and final achievement of that goal. It has been our observation that farmers do a better job of soil conservation, and are much more likely to maintain their conservation work in good order across the years, when they work together with their neighbors in friendly, natural groups. There is also much reason to believe that sound conservation work can be carried forward faster, and at a lower cost to all concerned, when farmers decide to work together on it in groups, in a really American, neighborly way.

The bankers, the hardware merchants, the seed and fertilizer dealers, the buyers, processors, transporters, and distributors of agricultural products, and many others are in a position to help, and in those cases where under the leadership of district governing bodies conservation has been made a primary community wide project, are helping in developing conservation farmers.

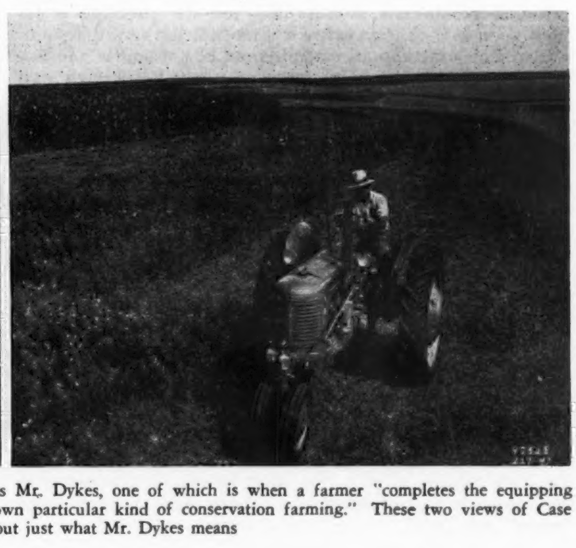
Our particular concern today, however, is with the retail farm equipment dealer and the equipment manufacturer who have such important roles in the development of farmers into conservation farmers.

As you remember, this participation begins with the farmer applying his conservation plan to his land, each acre of it. Nationwide it means new land use — better land use. It means new crops, new jobs for farm machinery such as terracing and the construction of diversions, dams and the blading of gullies for grassed waterways. In short, a new base for all farming operations has moved onto our scene, and farm machinery must also join the team for conservation farming.

As an onlooker you see this conservation farm slowly take on contour rows, terraces, strip cropping, grass and legumes on the steeper slopes, grassed waterways, trees in the gullied and otherwise unproductive areas, fence rows that wind around the slope on the contour. You see much of this coming about by the farmer using his own equipment, part of it the same farm machinery he has been using for years on his farm, but which before now has never been called on to perform these new soil and water-conserving tasks. The local farm equipment dealer and representatives of the farm equipment manufacturer are not mere onlookers. In many cases they have joined hands to help the farmer do as much as possible of his new conservation farming job with his present equipment, with only minor adaptations. Of course, where major changes are necessary, both dealer and manufacturer are plugging away to help equip the farm to permanently stay on the conservation landscape of our nation.

The importance of the right farm equipment cannot be overemphasized. The farmer who does not have the right tools to do conservation farming, is much more likely to to slip back to his old historical pattern. If he has the right tools and has not been taught to use them in farming the conservation way, he is also prone to backslide. The right equipment, properly used, means a lower cost of production and more profitable farming. Here is a real job for the equipment dealer and for the farm machinery manufacturer.

In addition to assisting the individual farmer in learning to use the equipment already available on his farm in applying conservation practices and measures and in conservation farming, local equipment dealers are in a position to render important service as a part of development step 4. In a growing number of states the legislatures are making sizeable appropriations for the purchase of needed equipment which is not ordinarily available on farms. District governing bodies of farmers who are most frequently responsible for the purchase of the equipment need the wise counsel of the local equipment dealers in selecting the machines to buy. It has

"Conservation farmers develop through logical step-by-step growth," says Mr. Dykes, one of which is when a farmer "completes the equipping of his farm with the necessary power units and implements to do his own particular kind of conservation farming." These two views of Case tractors and implements spell out just what Mr. Dykes means

been gladly granted in a number of instances but I am sorry to say that in others districts have ended up with equipment not fully useful or economical to operate due to high-pressure salesmanship. This, sad to relate, in a day when no salesmanship whatsover was required. Here is a job that requires unselfish service from the local group of dealers.

In many cases farmers working together in natural neighborhood groups (development step 7) make common use of certain pieces of farm machinery. Oftentimes they need to purchase new tools either to apply conservation practices or to do conservation farming in their neighborhood. They should receive the same sound guidance that district governing bodies get from the local group of equipment dealers. A mistake here affects a number of farms and its importance is therefore magnified.

Under the heading of giving credit where credit is due, I want to say that the farm equipment industry — manufacturers and dealers — have done an outstanding job to date. Their efforts top all other industry groups but this is quite natural. The farm equipment industry has an immediate and direct stake in conserving our soil and water resources and therefore a selfish interest in accelerating the development of conservation farmers. That does not take away the right to recognition for a job well done. We are making faster progress than many of you know. In the last fiscal year, ending June 30, 1948, here are just a few of the many accomplishments: 87,000 miles of terraces were built, 30,000 farm and ranch ponds were excavated, 218,000 acres of land were leveled for irrigation, and 1,000,000 acres of wet land were drained. I have purposely selected "equipment jobs" so you can share with the farmers and ranchers and with the technicians the pride of accomplishment. That same year 125,000 additional farmers became district cooperators and thus made the start towards becoming conservation farmers. About 10,000 a month are currently making the start. That is just about half fast enough, but it is indicative of the task confronting the farm equipment industry in making its contribution to the development of conservation farmers.

FARM EQUIPMENT INDUSTRY MAKES GOOD START

A good start has been made, but most of the job is ahead. The industry's already major contributions and known stake in the job being completed promptly and well has led me to drop a few questions into its lap which I hope agricultural engineers in general and the agricultural engineers and administrators of the industry in particular will find challenging.

1 When will the industry, on an industry-wide basis, assume the task of assisting farmers to utilize their present farm equipment in applying conservation practices to their land, and how to use it in conservation farming?

Several manufacturers and their retail outlets are doing an outstanding job now in this field, but the coverage is far from complete. The industry knows best the multiplicity of uses to which the various machines can be put and in addition knows the limitations. This seems so surely a legitimate part of the industry's job in developing conservation farmers that you will note that I have asked "when" rather than "will".

2 When will the industry, on an industry-wide basis, assume the responsibility for guiding soil conservation districts and their cooperating farmers in properly equipping the district and the farms with the tools for applying needed practices and measures, to do conservation farming?

Such a program to be practical and economical must provide for the fullest utilization of present equipment. The machines added must supplement those on hand. Each area and each farm will constitute a separate problem. Local dealers and manufacturers representatives will need to understand the conservation problems of the area and the changes in enterprises and farming practices that will accompany the conversion to conservation farming. Also, how these changes are likely to alter farm machinery requirements. This will require constant attention to the activities of the district and its cooperators. Much is being done along this line at present, but there are numerous gaps that must be closed if progress in the future is to be satisfactory. Again note I have asked "when" not "will".

3 Does the hiring of a trained agricultural engineer by the industry to be assigned to a soil conservation district as "farm machinery adviser" offer a key to answering questions 1 and 2?

Local dealers and manufacturers would share the cost of employing the engineer. He would work closely with the district governing body on its (the district's) equipment problems. He could survey equipment needs on each new cooperator's farm. He could advise on the purchase of the needed new equipment. He could keep local dealers informed on changing needs so the right tools will be available at the right time. He could arrange demonstrations on the use of present equipment in applying conservation practices. He could arrange for individual assistance by the appropriate local dealer in adapting or adjusting present equipment to new uses. He could keep the manufacturers informed of needed new tools and of the changes in design in current equipment essential to successful conservation farming. It seems to me that such a plan has much merit and while the industry would probably not want to tackle the task in all 2200 soil conservation districts right off, why not a trial in ten to 20 widely separated locations? Make the "farm machinery adviser" administratively responsible to a local dealers council, and after at least a two-year trial make a critical analysis of the results. Use the analysis as the basis for determining whether or not to expand the service to other districts. I am sure local district governing bodies will welcome the idea and will cooperate to the fullest.

WHAT WILL THE ENGINEERS DO ABOUT IT?

So far my questions have been directed primarily to the administrators of the farm equipment industry. Research, design, and testing engineers need not feel neglected, however, since the rest of my questions are addressed jointly to them and to the administrators.

4 When will practical native grass seed drills be available at prices farmers can afford to pay?

Our agronomists and range technicians tell us that such a drill must be capable of uniformly seeding very small quantities of mixed native grass seed — often in ounces per acre rather than pounds. Except for seed production it is usually desirable to seed combinations of grasses. Some of the seeds are light and fluffy and some are smooth and extremely fine. A way must be found to mix the various kinds of seed to produce the desirable combinations of grass cover. Such a drill should also have a furrow opener which will place the seed into the unworked ground with a controlled amount of cover. In the range areas such a drill must be a very sturdy piece of equipment that can be drawn over rough land at a moderate speed.

The reasons for mentioning the grass seed drill first are numerous. About 40,000,000 acres of our presently cultivated land are not capable of permanently returning a profit in cultivation. These steep and eroded lands need to be permanently retired to pasture and meadow. In addition, other millions of acres of our cropland will not be needed for tilled crops if present trends can be said to accurately forecast the future. These acres should go into long grass-legume rotations or into permanent pasture or meadow. Many millions of acres of range land now yielding a scant return can be made to produce excellent forage. Many short grass pastures would double their yields of forage if overseeded in strips with suitable intermediate and tall grasses. The grass seeding job ahead of us is staggering — call it roughly a 200 to 250 million acre job. Broadcast seeding has been tried and is unsatisfactory. Poor stands, lacking in uniformity, resulted from seed which is both scarce and expensive. It was impossible to properly cover the broadcast seedings. Some rather satisfactory native grass seed drills have been custom built for the supply is extremely limited and the cost high. The conservation farmer needs a native grass seed drill on his farm as a part of his regular equipment. When will he get it?

5 Why not establish an industry-wide research project on control of the "invaders" of our range lands?

(Continued on page 428)

Applications of Torque Converters in Farm Machines

By C. E. Frudden
MEMBER A.S.A.E.

HYDRAULIC torque converters go back several years for their beginnings, but the engineering refinements required to make these devices reasonably efficient and commercially practical have required many years of intensive research, and only with the past five or six years have automotive vehicles such as tractors and city-type busses so equipped reached the market in any large numbers.

In city-type bus service, with its frequent stop and start requirements, the need for rapid acceleration, and perhaps above all relief for the driver from frequent clutch operation and gear shifting, the torque converter has opened up a very promising field, so much so that a high percentage of all city-type busses now going into service are torque-converter equipped.

In the automobile field, Buick with its dynaflow and Packard with its new transmission system have demonstrated the advantages of torque converters for luxury transportation.

As to tractors, Allis-Chalmers has since 1940 built several thousand torque-converter-equipped tractors for industrial and military use. For the past two years the HD-19 tractor has been built and sold in considerable volume. This particular model of track-type tractor weighs 40,000 lb. It is equipped with a three-stage torque converter in combination with a two-speed and reverse-gear system. This paper will deal with certain characteristics of and experiences with the HD-19 tractor based upon factory tests and also Nebraska Test No. 397, and from this information an attempt will be made to evaluate the possibilities for a hydraulic torque-converter-equipped tractor in the agricultural field.

An elementary torque-converter application to a tractor is shown in Fig. 1. The four elements are engine, pump, turbine, and geared transmission system. In operation the engine runs essentially at constant speed driving a centrifugal pump. A fluid, generally a light oil, is delivered at high velocity to the blades of a turbine. The turbine drives the geared mechanism for propelling the tractor. Whereas the pump runs essentially at constant speed, the turbine runs fast or slow, just like a series type electric motor, adjusting its speed automatically to the load. Delivered torque is high and speed is low for the heavy loads, and vice versa for light loads, while the input torque remains unchanged. This example is of course very much oversimplified, but it states the principals which are involved.

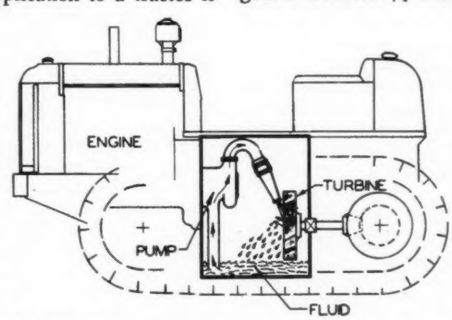


Fig. 1 Elementary torque converter, illustrating principle and working parts

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division.

C. E. FRUDDEN is consulting engineer, tractor division, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Actually the torque converter (Fig. 2) which is part of the HD-19 tractor is a highly refined piece of equipment, with a very efficient pump and turbine combination, all assembled into one compact unit. The pump runner is nested inside the turbine wheel and both units are enclosed in the casing which serves as the two-stage reaction member for the three turbine stages. Fig. 2 shows the three elements of the torque converter, with the pump runner at the left, the turbine wheel with its three sets of blades in the center, and the reaction member at the right with its two sets of blades for redirecting the fluid flow from one stage to the next.

The HD-19 tractor is shown in cross section in Fig. 3. The engine is a diesel delivering 163 hp net at 1750 rpm. A clutch is provided at the engine flywheel. This is a conventional friction clutch used when shifting gears or when it is desired to disconnect the engine from the transmission system. Practically no heat is generated within the clutch so it never wears out. Its only requirement is ability to transmit the engine torque when in its engaged position. The torque converter is the next unit in the power line, then a two-speed and reverse-gear box. The ratio between high and low gear is 2.6 to 1. As will be shown later, the most efficient range for low gear is between ¾ and 2½ mph. In high gear the most efficient range is from 1¾ to 6¼ mph. As a matter of practical operation, low gear is used only for heavy loads at slow speeds; most operations are carried on in high gear. The radiator on this tractor serves a dual purpose. About three-quarters of the frontal area is devoted to cooling the water in the engine cooling system; the remaining one-quarter cools the fluid which circulates through the converter. The fluid used in the converter is the same diesel fuel on which the engine operates, and is taken from the regular fuel supply tank. The heat ordinarily generated within a friction

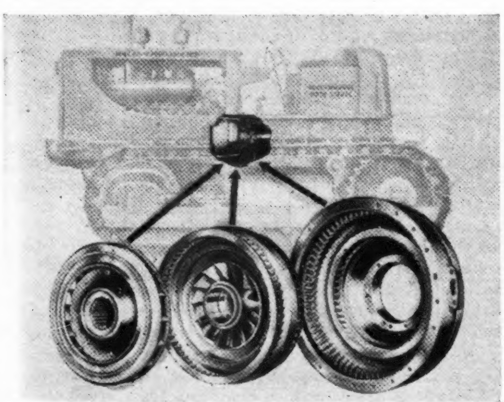


Fig. 2 Main elements of the torque converter in Allis-Chalmers HD-19 tractor

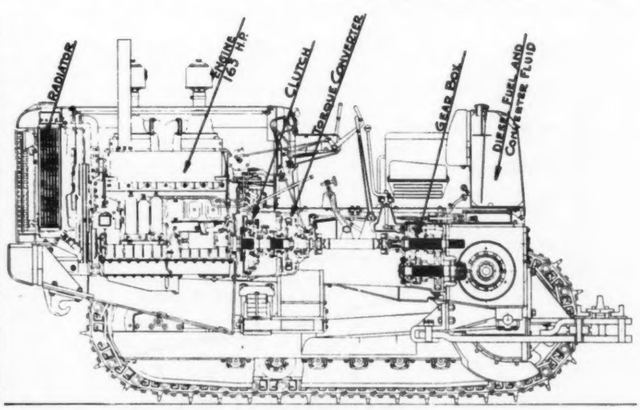


Fig. 3 Cross section of HD-19 tractor indicating main elements in drawbar power train

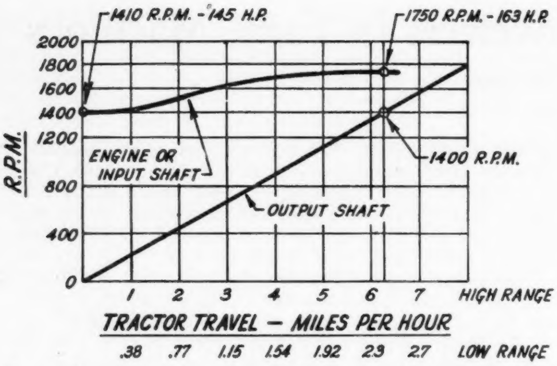


Fig. 4 Operating characteristics of HD-19 tractor in starting load and increasing speed

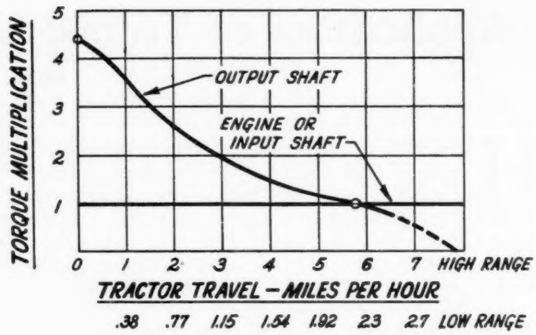


Fig. 5 Torque multiplication in relation to speed

clutch is absorbed by the fluid, and of course the converter is not 100 per cent efficient, hence the requirements for a special cooling system. The oil cooling radiator is of sufficient capacity to maintain reasonable oil temperatures under continuous full-load operation between 1¾ and 6¼ mph in the high-gear range. Outside of this speed range, overheating may occur and continuous running under these conditions is accordingly not recommended.

The operating characteristics of a torque-converter tractor can be shown in Fig. 4 and 5. These charts and the ones to follow all refer to operations under full engine power at 1750 rpm, or such lower engine speeds as are automatically provided by the system. In Fig. 4 the two converging lines show what happens when the load is started and what happens when the tractor gains speed. As the load is started (tractor speed zero), the engine speed settles at 1410 rpm where it develops 145 hp. As the converter output shaft picks up speed and the tractor travel speed increases, the engine speed also increases until at 6¼ mph the engine runs 1750 rpm and delivers 163 hp. There is a fixed relationship between engine speed and tractor speed. As just stated, with the tractor speed zero and starting a heavy load, the engine speed settles down at 1410 rpm. It never goes below this speed. There is no worry about stalling the engine, and engine operation is favored to the extent that the engine is never called upon to "lug," which isn't good practice in the operation of diesels.

Fig. 5 shows the torque multiplication obtained through the converter. At 5¾ mph (tractor speed), engine torque and output shaft torque are equal, that is, torque ratio equals 1 to 1. At reduced speeds torque increases until at zero speed engine torque is multiplied 4.4 times when it reaches the output shaft.

While Fig. 5 shows the relationship between speed and torque at input and output shafts of the converter, Fig. 6 shows the relationship between tractor drawbar pull and tractor speed. This pair of curves takes into account the fact that rolling resistance and track losses increase with speed, making more drawbar pull available at low speeds and less at high. The "points" on the curves have been taken from Nebraska Test No. 397 and indicate what may be expected under similar test-track conditions. Note that in low gear a theoretical drawbar pull of 70,000 lb is possible, but ordinarily the limit of traction is about 90 per cent of weight before slippage becomes excessive; hence the indicated limit is shown as 36,000 lb. A maximum drawbar pull of 27,500 lb is obtained in high gear.

The story as to available drawbar horsepower and an accounting of the losses between the engine crankshaft and the drawbar can be shown in Fig. 7. The engine delivers 163 hp at 1750 rpm. The losses due to gears, tractor rolling resistance, and track friction amount to about 20 hp at relatively slow speed, up to about 45 hp at 7 mph as shown by the shaded area. The actual net drawbar horsepower as reported in Nebraska Test No. 397, is shown for both low and high-gear ranges. Power losses through the converter are shown by the area above the drawbar horsepower curves and below the shaded area.

To assess the advantages and disadvantages of a torque-converter tractor in comparison with one equipped with a multiple-step speed change gearset, is no easy job. To make a start, however, let us say the torque converter and its allied equipment increases the first cost of the tractor, and admit also that the consumption of fuel is higher. This is about all that can be said on the debit side of the converter account.

On the credit side, it can be said that under conditions where loads are variable and quick changing, or where heavy loads are to be started frequently, the converter-equipped tractor, for the same or even less available drawbar horsepower, will actually accomplish more work in a given period of time. In many cases the value of the extra work done easily offsets the extra first cost and the cost of the additional fuel consumed. Perhaps the greatest advantage accrues to the operator who has an easy time of it, driving a converter trac-

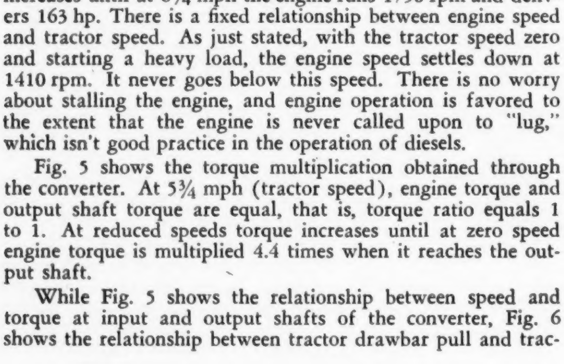


Fig. 6 Relation between drawbar pull and speed with torque converter transmission

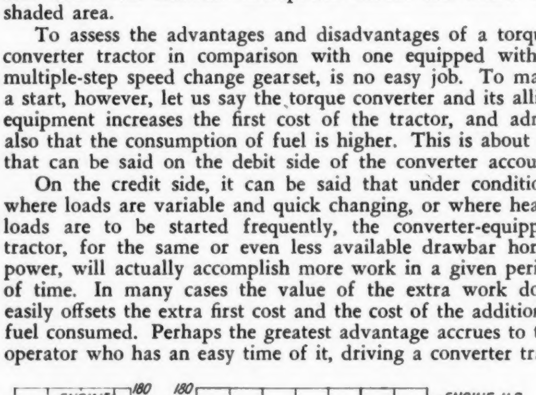


Fig. 7 Losses and available horsepower in relation to speed

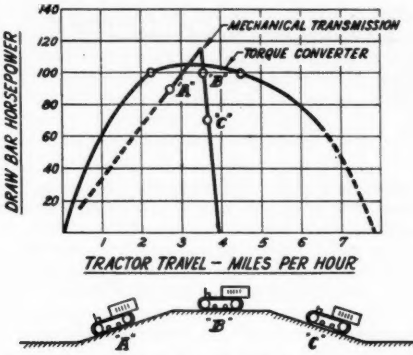


Fig. 8 Power-delivery characteristics of the torque converter under variable load compared with mechanical transmission

tor, and that is an item of no mean importance among the contractor's problems.

How the extra work turned out per day is accomplished can be shown in Fig. 8. For purposes of comparison, the actual drawbar horsepower curve for the HD-19 tractor is shown for its high gear range. It is assumed here that gears, clutches, shafts and sprockets in a similar tractor with mechanical transmission are capable of transmitting say 10 per cent more maximum power than the converter tractor, and on that basis a single gear speed selection is shown superimposed on the converter horsepower curve. Now consider a tractor operating under variable load conditions which are not conducive to changing of gears — that is, the operator must select one gear ratio for the load cycle. He can start out at A in a gear which overloads the engine, reduces the speed of travel until he has abailable, let us say, only 90 db-hp instead of 120. When he reaches level ground at B, the engine very likely comes under governor control, and because its speed is controlled, he has available, let us say, 100 db-hp out of a possible 120 maximum. Then when he gets into the position C, the engine governor still further restricts the power output and he has available only 70 db-hp. His power factor is low. He hasn't used the tractor to its full capacity.

Consider now the converter tractor. The operator has from 100 to 105 db-hp available throughout the range from 2¼ to 4½ mph. He operates on a higher load factor and he gets more work done. Of course he has burned more fuel per hour, but that is a small item as compared with the possible gain in work done under the conditions set up in this example.

This constitutes the story of the HD-19 tractor with a complete engineering record of its performance under widely different conditions of operation. It is a spectacular performing tractor under the more difficult operations. The rougher and tougher the job, the better the showing which the torque converter can make in a track-type tractor.

As to possible applications of torque converters to farm tractors, the simple replacement of a conventional four or six-speed gear box with a torque converter offers few advantages and sets up some still unsolved problems.

It has been shown that the converter does its best work under conditions where the loads fluctuate over a wide range, which situation, in the case of friction clutch and multiple-speed gear box operation, calls for frequent gear shifting and clutch manipulation and generally a low load factor for the tractor. Such a situation is unusual in most farm tractor operation, especially for such jobs as seedbed preparation, planting, cultivating, and harvesting. On these jobs the loads are fairly steady and gear shifting is infrequent. For such jobs as land leveling, land clearing, fence stretching, and perhaps manure loading some advantages may accrue to the converter.

And again the farm tractor, as we know it now, is often required to travel at a constant speed; also its power take-off drives, both rear and belt pulley, must maintain constant speeds regardless of load. Combines driven from the tractor power take-off are a good example. An increased speed going down hill and a decreased speed going up can not be permitted.

Torque converters add both to the initial cost of the tractor and to its cost for fuel consumed. Increased performance is necessary to absorb these costs.

It seems, at this writing, that our current conventional tractors will not be greatly improved by the substitution of a hydraulic converter for a change-speed gear box. This is not saying, however, that some new concepts in the design of power transmission systems will not make the converter a desirable item for farm tractor use.

Cows Heat House

By Nils Holmquist

MEMBER A.S.A.E.

WE USUALLY have a special furnace for heating our homes, but we expect our domestic animals, especially the cows to heat their own shelters. An average milking cow produces about 20,000 calories per day. Out of this heat about 25 per cent is latent, in respiratory moisture.

Swedish research has indicated a need of between 40 to 80 per cent of the sensible heat for ventilation. The rest of it, that is, about 40 per cent as an average, disappears in transmission losses.

About 60 per cent of the sensible heat, plus all of the latent heat, is in fact wasted, as it is ventilated away without having been used in the barn.

Most new or rebuilt barns are so well insulated that the remaining heat will be sufficient for keeping the temperature in the barn high enough for most weather conditions.

In some recent Swedish tests we have tried to make use of this wasted heat for heating the house. It is not possible to introduce the barn air directly to the house, as the temperature in the barn is too low to make it possible to keep the temperature in the house as high as desired. The only way to accomplish it is to "pump" the heat to a higher temperature through a heat pump.

In our project we have principally placed the evaporator in the duct for the outgoing air from the barn. By passing the air over the evaporator, we are able to remove as much of the latent and sensible heat from it as we want to and as may be economically desirable. All of that heat is pumped to the condenser, which is placed in the house. The best and cheapest way of using the heat is to use a heating system with air that takes its heat from the compressor and condenser and is forced to the different parts of the house by the means of a fan. The heat from the fan motor is also used in heating the air.

In our tests we have given the warm air the possibility of recirculating in the barn. As the air is dehumidified to a certain extent, this system gives very good results and enables us to use the excess heat more efficiently.

When the compressor is not working, being turned off by a thermostat in the house, the barn ventilation is taken care of by means of a regular flue (natural draft or fan ventilation) with a thermostatic control to keep the temperature at 59 F.

The location of our test house is such that the lowest design temperature at which the heating system should be calculated is 5 F. Those extreme low temperatures are, however, very rare and calculations show that it is economically most correct to dimension the heat pump for an outside temperature of 28.4 F and to add the extra heat needed for the cold periods by means of direct electrical heating.

As the temperature of the freon refrigerant is only about 39.2 F, when it is pumped from the barn to the house, the pipes could be uninsulated without serious heat losses. The distance from the barn to the house may be even as long as 100 meters.

With this system a barn with only 10 to 15 milking cows is sufficient for heating a normal *(Continued on page 428)*

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

NILS HOLMQUIST is chief engineer, Swedish Government Research Institute for Farm Buildings, Lund, Sweden.

Present Status of Hydraulic Torque Converter Development

By Wilbur F. Shurts

HYDRAULIC power transmissions of the hydrokinetic type are comparatively old, but not until ten to fifteen years ago did it become apparent that the field of application was large enough to justify the rather expensive tooling required to produce these units. The hydraulic coupling first came into general usage, as it can be designed with very little theory, and if it slips too much, just build it bigger. The unit cost and the tooling need not be too high.

The hydraulic torque converter was slower in reaching the market as a long development procedure is required to get efficient units, and radically different manufacturing processes had to be developed in order to produce these units. The unit cost is rather high and the tooling is quite expensive. The hydraulic torque converter is an automatically, infinitely variable torque ratio transmission which, within its designed range of operation, will immediately adjust the speed of the load to correspond to the resistance to moving the load. In other words, the hydraulic torque converter is a device which automatically increases the leverage or mechanical advantage when the load increases. The various types of torque converters vary widely as to their design. The only point of similarity is that roughly they have a torus or doughnut circuit shape, have multiple-blade stages, and use a petroleum product as their power transmitting medium. Units in production today are shown in Figs. 1 to 7.

The performance characteristics vary as widely as the appearance of the circuits indicate that they should. Some units are designed to operate strictly as hydraulic torque converters at all times. Others are built as a combination hydraulic torque converter and hydraulic coupling, and still others incorporate a direct-drive clutch to secure highly efficient operation in the high-speed end of the curve.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division.

WILBUR F. SHURTS is chief engineer, hydraulic division, Twin Disc Clutch Co., Rockford, Ill.

Figs. 1, 2, and 3 show hydraulic torque converter circuits based on the single-stage type. Fig. 1 is a unit developed by Schneider Brothers which contains three elements — a pump, a turbine, and a reaction member. The housing rotates at engine speed, and as the reaction member is mounted on a freewheel unit, the torque converter becomes an hydraulic coupling in the high-speed end of the curve when torque multiplication is no longer required. This torque converter develops more than three times engine torque with the output shaft stalled.

The curve below the circuit diagram indicates the general performance characteristics with engine speed expressed as per cent of engine governed speed. The three curves — engine speed, efficiency, and torque ratio — are plotted versus output speed as per cent of engine governed speed. This type of circuit results in the engine speed at stall being somewhat higher than the engine speed through the normal working part of the range.

Fig. 2 shows the Buick Dynaflow which is a five-element torque converter referred to as the polyphase type. In order to develop a unit suitable for an automobile drive, the guide stage has been split into two parts. Also the pump has its more sharply curved portion at the inlet split off and freewheeled. The two guide stages are freewheeled to a stationary member whereas the secondary pump is freewheeled from the main pump wheel. This likewise has the rotating pump housing and becomes an hydraulic coupling at high speeds. By this means they are able to get a continuously rising engine speed curve and continuously rising efficiency curve. Due to the high power to weight ratio of a modern automobile, high torque ratios are not required in the torque converter.

The Allison torque converter (Fig. 3) is a modification

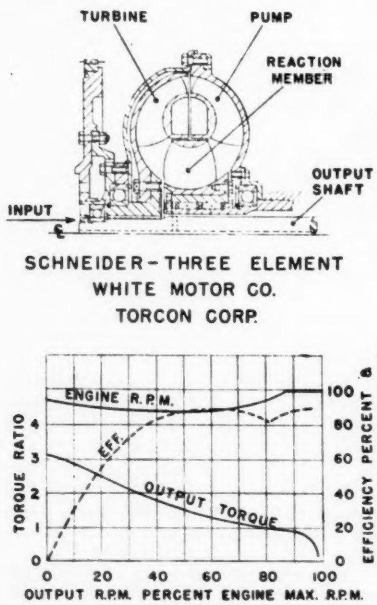


Fig. 1

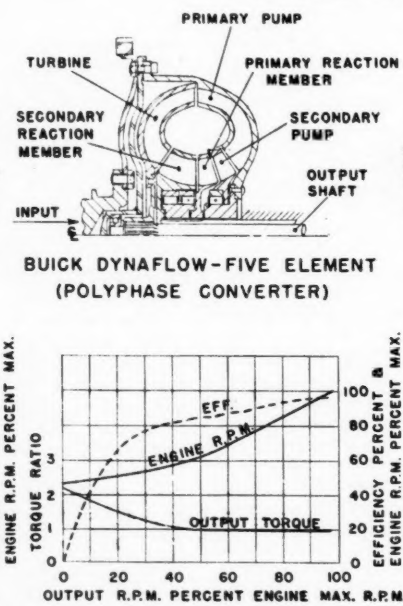


Fig. 2

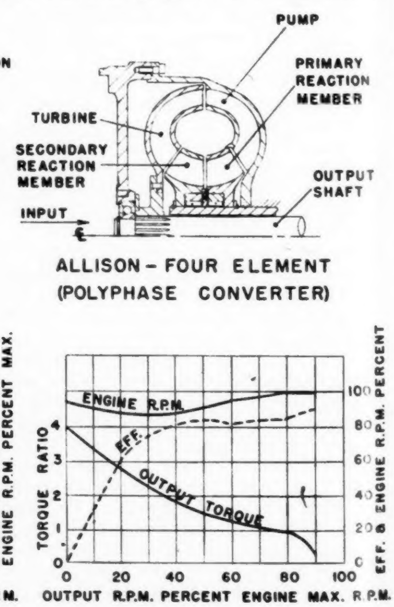


Fig. 3

Figs. 1, 2, and 3 show hydraulic torque converters of the basic single-stage type, with combined hydraulic coupling action and rotating pump housing with freewheeled reaction elements

of the Buick type with the omission of the secondary pump and is therefore a four-element, polyphase-type converter. Stall torque ratios of about 4 to 1 are secured and the engine speed curve shows the same characteristics as the Schneider unit, in that the engine speed with the output shaft stalled is higher than in the normal working range. The split guide stage results in a more uniform efficiency curve.

In Figs. 4 and 5 are shown the two-stage type torque converters in production. Fig. 4 shows the General Motors truck and coach V drive as used in the buses at the present time. This is a stationary-housing-type torque converter with a fixed reaction member and employs direct drive for the high-speed operation with clutches and freewheels arranged so that the hydraulic circuit does not rotate when the direct-drive clutch is engaged. The two-stage-type torque converter is characterized by having two turbine stages and a single-guide stage, whereas all the single-stage-type have a single turbine element. This type circuit gives stall torque ratios over 4 to 1 and results in a continuously rising engine speed curve. In Fig. 5 is shown the Packard Ultramatic two-stage torque converter which has a housing rotating at engine speed and a freewheeled reaction member. A direct-drive clutch is engaged for high-speed operation and a single reaction member is freewheeled to eliminate hydraulic losses in the high-speed end of the curve. This unit develops around 2.4 times engine torque at stall and shows the rather steeply and continuously rising engine speed curve as required for automotive application.

In Figs. 6 and 7 are diagrammatic views of the two three-stage-type hydraulic torque converters which are based on the Lysholm-Smith system. The three-stage converter is so named because of the three turbine blade sets which have interposed two stationary reaction members. The unit as developed by Twin Disc Clutch Co. produces about five times engine torque with the output shaft stalled and is bladed so as to maintain the engine at near maximum governed speed through the working range. The direct-drive clutch may or may not be used as required by the application. The Spicer torque converter as developed for automotive service has about six times engine torque at stall and has a steeply rising engine speed characteristic typical of automotive-type drives. A direct-drive clutch is used to get the high-speed operation.

The blading of all types may be modified to produce higher output torque at high speeds with resulting loss in torque ratio at low speeds. The design of a combination hydraulic torque converter and hydraulic coupling introduces a compromise in size due to the fact that the torque converter must be too large or the hydraulic coupling too small when the engine has a fixed top-governed speed.

The goal of the converter design engineer is normally to match the engine and torque converter performance so that the engine is pulled down to its peak torque speed at stall for three reasons. First, output torque is the product of engine torque and stall torque ratio; therefore, by pulling the engine down to its peak torque at stall, more output is available for a given stall torque ratio. Second, at stall the efficiency is zero; therefore, the lower the engine speed, the less the fuel consumption. Third, it follows that the heat generation will be less.

As the vehicle or load begins to move, it is the designer's next object to have the efficiency rise as rapidly as possible thus producing more output torque and horsepower to do work. Also the engine speed should rise rapidly to permit the engine to produce more power to get more work done. Considering only industrial applications with a governed speed, and ignoring automotive drives, the designer's next problem is to produce a converter that demands as nearly as possible constant horsepower over the normal efficient operating range, thus maintaining constant engine speed and maximum engine power regardless of operating speeds. High-speed operation, up to engine speed, may be secured with a direct-drive clutch, partially obtained with a combination torque converter and hydraulic coupling, or restricted by means of a governor which controls the engine speed from the converter output speed.

The next problem is what can be done with the unit. As the torque converters are automatically infinitely variable, they do not lend themselves to constant-speed requirements unless an output shaft governor or direct-drive clutch permitting control by the engine governor is used. The torque converter is not a clutch. To get neutral, a master clutch or power shift transmission with clutches or bands for individual transmission speeds is required.

The torque converter is extremely desirable for those jobs which require maximum horsepower and the ability to move the load at the maximum speed that the drawbar pull demand will permit. Plowing, disking, harrowing, and the other utility attachments such as a loader, scraper blade, or pulling loaded wagons are examples. On light-load, constant-speed operations, such as planting or harvesting, a direct-drive

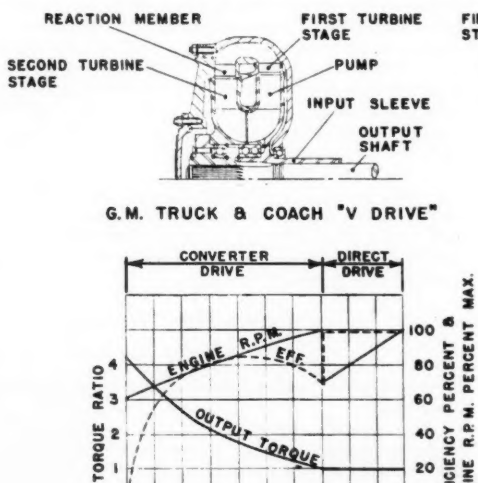


Fig. 4

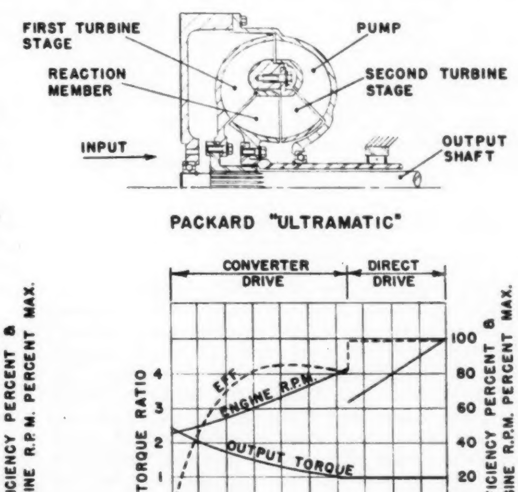


Fig. 5

Figs. 4 and 5 are hydraulic torque converters of the two-stage type: stationary-housing, fixed-reaction member (Fig. 4), and rotating-housing, freewheeled reaction member (Fig. 5)

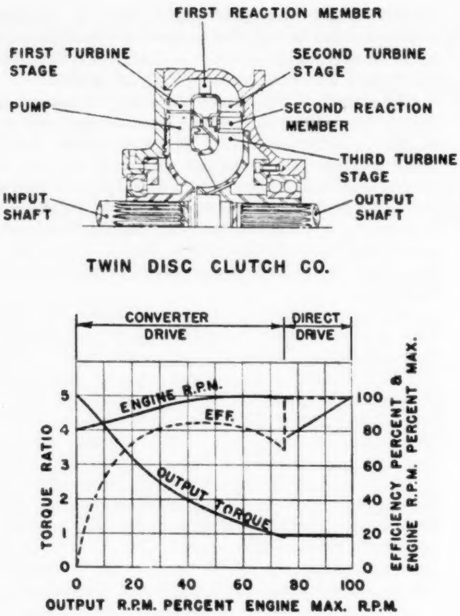


Fig. 6

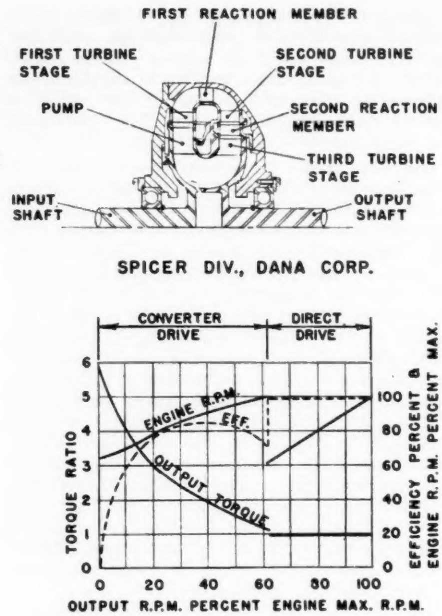


Fig. 7

Figs. 6 and 7 are hydraulic torque converters of the three-stage type (Lyshold-Smith), stationary housing, fixed reaction member

clutch with speed control by the engine governor seems most logical. Cultivation may require hydraulic or direct-drive depending upon ground conditions.

The inclusion of an hydraulic torque converter in a farm tractor transmission is a perfectly logical development. This converter should have a stall torque ratio of about 3.5 to 1.0. It would probably be followed by a three-speed and reverse transmission giving maximum forward speeds of 4, 8, and 16 mph in direct drive. In torque converter drive the speeds would be 1.2 to 2.8 mph in low, 2.4 to 5.5 mph in second, and 4.8 to 11.2 mph in high. The big problem at the present time is perfecting of the methods of manufacture to reduce the cost of hydrokinetic-type transmissions. The Packard Ultramatic and Buick Dynaflow are about the right size for the average wheel-type tractor. In the automobile these units carry high horsepower, but as the horsepower varies as the cube of the engine speed, they have about the right capacity at tractor engine speeds. These automotive transmissions list at $200 to $225 which is the net extra over and above the cost of a conventional clutch and three-speed transmission. There is therefore much work to be done before this type of transmission is commercially practical for a farm tractor.

Machinery for Conservation

(Continued from page 422)

Under heavy grazing of the past, which depleted the climax vegetation, the encroachment of sage brush, mesquite, shinnery oak and cedar has been extremely rapid. Before much of the range land mentioned previously can be successfully reseeded it will be necessary to remove these woody "invaders". Much work has been done on this job by individual companies and by federal and state agencies. Ranchers and range technicians tell me that, while progress has been made, in the main the costs are high and the practical, economical answer to "invader" control by either mechanical or chemical means is still to be found. Why not a unified effort to find that answer?

6 Why not design the farm machinery of the future for conservation farming?

Admittedly it will take twenty or more years to complete the conversion. But the task is well started with over 700,000 farmers and ranchers operating 187,000,000 acres already tackling their conversion problems. Farm machinery designed for conservation farming and available when the present tools must be replaced will speed the conversion. Much progress has been made — some of it intentionally and some of it accidentally. For example, front-mounted equipment permits more accurate control in the use of such conservation-farming practices as contour cultivation and strip cropping. Press wheel carriage has been found to be desirable for grain drills in the Pacific Northwest as it provides for greater stability in cross-slope cultivation of the hillsides. It also assists by pressing the seed into the soil so that it can obtain sufficient moisture to germinate. Hydraulic controls are also very helpful in conservation farming. The ability to lift knives and blades from the ground quickly, accurately, and easily is of great help when a farmer must come close to or cross a waterway, a terrace, or a bladed-in, seeded gully.

No one would venture a prediction at this time of the exact machinery needs of the conservation farmer. These needs will develop just as farmers develop into conservation farmers by step by step logical growth. The farm equipment industry will find it rewarding to keep pace. Without the right kind of equipment the job cannot be done, and without the right kind of equipment to do conservation farming, it will not stay done. The job is too important to the industry and to all people for us to falter now. We must all do our part in developing 5,800,000 conservation farmers in the shortest time possible.

Cows Heat House

(Continued from page 425)

five-room house, without extra insulation either in the barn or the house.

Economically this system should be compared with other means of central heating. In Sweden the most common fuels are oil and coal. With a depreciation in 10 to 25 years (for different parts of the aggregate), a cost of 2 c per kw-hr for electricity and a cost of $45 per ton of heating oil, it is shown that the arrangement with the heat pump will cost $190 per year, compared to $245 for the oil furnace.

The installation was tried in Sweden last winter and preliminary calculations from the tests show that the system is practically and economically realizable.

Method of Drawbar Testing at the Nebraska Tractor Testing Laboratory

By C. W. Smith and L. F. Larsen
MEMBER A.S.A.E. MEMBER A.S.A.E.

TRACTOR testing began at the University of Nebraska in 1920 and has continued until the present time, having been interrupted only during the war years, 1942 to 1945, inclusive. Drawbar testing has been an important part of the work from the beginning. Its aim has been to develop data that would show drawbar pull, fuel consumption, slippage, rate of travel, horsepower, and to a lesser extent, stamina.

Fig. 1 The Nebraska Tractor Testing Laboratory at the University of Nebraska

Drawbar pull has always been determined by means of a hydraulic cylinder inserted in the hitch between the tractor being tested and the load. The piston in the hydraulic cylinder has a head area of 10 sq in, and the pressure imposed on it by the tractor is transmitted to an indicator with a calibrated spring.

The stylus of the indicator makes a continuous tracing on a sensitized paper for a distance of 500 ft on the testing course. The chart thus created is measured by a rolling planimeter and from its length and area the average drawbar pull is determined. The slippage is determined by counting the number of revolutions the drivewheels make under load and comparing them with the number of revolutions made with no load in traveling 500 ft. Rate of travel is determined by stopwatch. Fuel consumption is measured for a 10-hr continuous run.

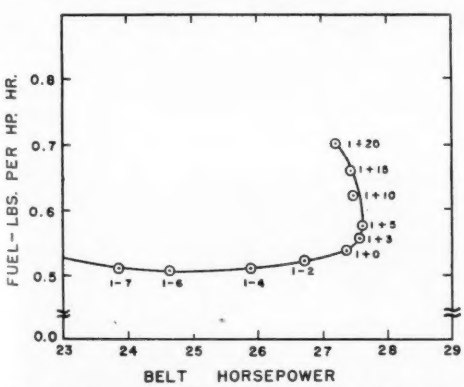
This, in brief, is the procedure, but each one of these steps involves meticulous care and the details involved are our main concern at this time. They may be approached in the following order: (1) calibration of indicator spring, (2) preparation of the tractor, (3) setting the ignition and carburetor, (4) determination of the effective circumference of the drivewheels, (5) determination of slippage, (6) height of hitch, (7) preparation of dirt course, (8) measuring fuel consumption, (9) drawbar tests, (10) weighing, (11) inspecting, (12) drawbar testing equipment and technique, and (13) reports.

1 *Calibration of Indicator Spring.* Calibration of the indicator spring is accomplished by means of a dead-weight tester. The theory of this is based on Hooke's Law which states that, within the elastic limit, stress is proportional to the strain. The dead-weight tester is attached to the hydraulic cylinder, and the pressure imposed by it on the oil is transmitted by a flexible hose to the indicator in the instrument car. All equipment and instruments are in the same relative positions as when used in a test. Increments of weight are first added and then removed from the tester and a series of readings are taken both in the ascending and descending order. These correspond quite closely but not exactly. Where any difference exists, the average value is used.

2 *Preparation of the Tractor.* The regular procedure in preparing the tractor for test requires that the crankcase be drained and then filled with oil of the grade specified in the application for test. The specifications in this regard must agree with the manufacturer's recommendations to the trade. Ballast, usually consisting of cast iron and liquid, is then added to the wheels. This may equal but not exceed the maximum weight specified by the Tire and Rim Association. The tractor is then started on Test A, 12-hr limber-up run. During this test the tractor pulls approximately one- third of its rated load for four hours, two-thirds for four hours, and full load for the remaining time. Time is the only item recorded for this run. The manufacturer's representative operates the tractor during this test, the purpose of which is to limber up the machine and give an opportunity to make any adjustments

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division.

C. W. SMITH and L. F. LARSEN are, respectively, chairman of the tractor testing board and engineer in charge of tests, Nebraska Tractor Testing Laboratory, University of Nebraska, Lincoln.



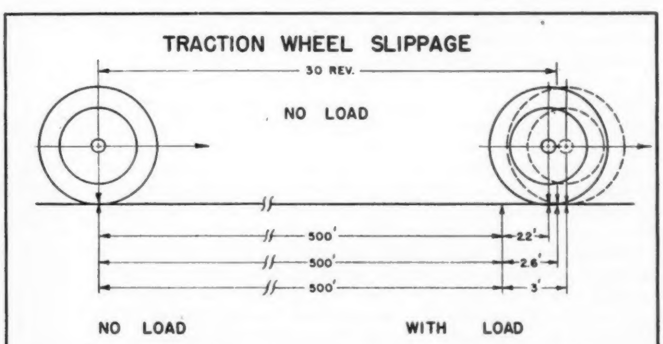


Fig. 2 (*Above*) The "fishhook" — data plotted from several carbureter settings. A vertical line tangent to this curve designates the 100 per cent maximum horsepower carbureter setting. The operating maximum horsepower carburetor may be the same but is usually slightly less, with better fuel economy. Fig. 3 (*Right*) Tractor wheel slippage

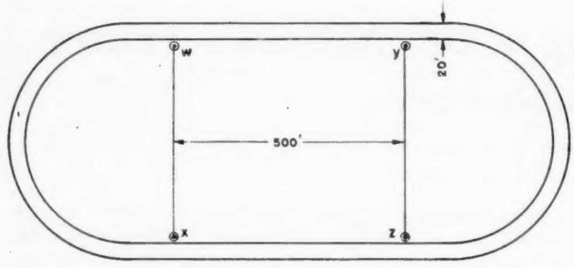


Fig. 4 Tractor testing course. Tests A, F, G, H, J, and K, are made on this dirt testing course, which is 2200 ft in circumference. These are two 500-ft runs, one on each side. W, X, Y, and Z and four iron posts used for lines of sight in starting and stopping 500-ft charts

which may be needed before the tractor is turned over to the University's engineers who operate it for all subsequent tests.

3 *Setting the Ignition and Carburetor.* Test B, the 100 per cent maximum belt horsepower test, is next in order and is included at this point because it is the basis for making ignition and carburetor settings used on all subsequent tests, both drawbar and belt. The tractor is belted to the electric dynamometer, and after being thoroughly warmed up the carburetor throttle is opened wide and sufficient load applied to pull the tractor engine down to rated speed. The ignition and carburetor are adjusted to give maximum horsepower. The carburetor setting is such that making the mixture richer will not increase the horsepower but making it leaner will decrease it. This carburetor setting is used for Test F, the 100 per cent drawbar horsepower test. Following Test B, the manufacturer's representative designates a carburetor setting to be used for all other belt and drawbar tests. It may be the same as that used in Test B but is usually somewhat leaner giving a little less horsepower but greater efficiency. This is called the "operating setting", and is thought to be the best for all normal operation of the tractor. In arriving at the 100 per cent maximum and the operating maximum settings sufficient data are secured to plot a fishhook (Fig. 2).

4 *Determination of Effective Circumference of the Drivewheels.* To determine the effective circumference of the drivewheels, two chalk lines are snapped across the tractor testing course exactly 500 ft apart. The tractor is driven slowly over the first of these two lines and a mark placed on each tire exactly above the line. The tractor is then driven slowly with no load until it barely crosses the second line and enough further until the mark on one tire and then that of the other are directly under the axle. These added distances are each added to 500 ft. This procedure is repeated on the opposite side of the testing course giving four readings of distance covered by the drivewheels in a certain number of revolutions. These four readings are averaged and the result divided by the number of revolutions. The quotient is the *effective circumference* of the drivewheels.

5 *Determination of Slippage (Fig. 3).* There are two pairs of iron posts set within the tractor testing oval and a line joining one pair of posts is exactly 500 ft from that joining the other pair. The engineer in the instrument car throws a switch starting wheel counters and a stop watch the instant he passes one pair of these posts. He stops them the instant he passes the second pair. The counters give the exact revolutions of the drivewheels to one-tenth of a revolution in traveling 500 ft. When the tractor is pulling, it requires more revolutions of the traction wheels, due to slippage, to travel 500 ft than when traveling with no load. Let A be the effective circumference of the traction wheels and N the revolutions made under load. Then $[(AN - 500)/AN] \times 100 =$ per cent slippage.

6 *Height of Hitch.* It is common knowledge that the height of hitch has a direct influence on the amount of weight transferred from the front of a tractor to the rear when it is pulling. Thus far the manufacturer has had the privilege of saying what the height shall be when testing his tractor. All, however, are urged to conform as closely as possible to the ASAE standard. The height used is measured and reported.

7 *Preparation of the Dirt Course.* The dirt course upon which all drawbar tests are made is a graded road, oval in form (Fig. 4), with straight parallel sides. It is located in an area where the soil is described as Waukesha silty clay loam which becomes very sticky when wet, but which can, with the proper moisture content be packed and rolled into a surface closely resembling that of a hard-surfaced highway. In preparation for drawbar testing the course is sprinkled and rolled as often as necessary. Experience has made it possible to get remarkably similar surfaces for tests in recent years.

8 *Measuring Fuel Consumption.* On only one drawbar test, Test H, is fuel consumption measured. It has been done by filling the tractor fuel tank at the beginning of the ten-hour run, measuring that which was added during the test, and at the conclusion draining from the tank the fuel not used and crediting it to the tractor. The work connected with these fuel consumption measurements has been simplified recently by an auxiliary fuel tank for all preliminary and final maneuvers of the tractor when not actually on test. The main tank is filled to begin Test H. It is filled again to the same height at the conclusion. This procedure makes it easier to get fuel consumption for ten hours. The tractor is filled while standing on a floor within the laboratory and refilled at the same place.

9 *Drawbar Tests.* Six different tests are made on the drawbar. The first, Test A, the limber-up run, has been described. No data from this test are tabulated in the report.

Test F, the 100 per cent maximum drawbar test, is made with the 100 per cent maximum belt test carburetor setting. Data from this test give the basis for computing a drawbar rating for the tractor. The drawbar rating when computed is derived in the following manner:

$$DHP_c = DHP_o \times \frac{P_s}{P_o} \times \sqrt{\frac{T_o}{T_s}}$$

Fig. 5 Following the routine tests at the Nebraska Laboratory, a tractor is given a final inspection, at which time burned valves, scored cylinder walls and pistons, broken rings, damaged bearings, etc., are noted

Fig. 6 This picture shows two new drawbar loading units — an Oliver 88 and a Massey-Harris 55 tractor. The load is regulated by throttling the exhaust. Note that the front end of the rear unit is supported on the drawbar of the unit ahead

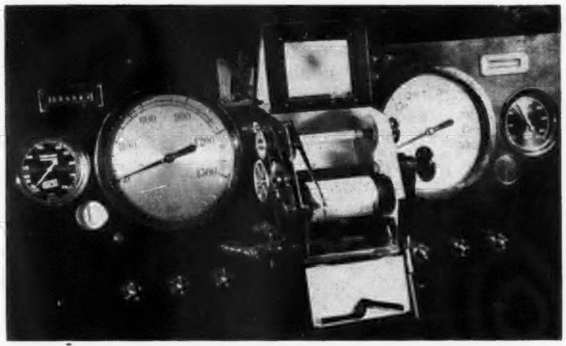


Fig. 7 The panel in the instrument car showing the arrangement of taking drawbar testing charts

where DHP_c = drawbar horsepower corrected
DHP_o = drawbar horsepower observed
P_s = standard barometric pressure
P_o = observed barometric pressure
T_o = absolute temperature, observed
T_s = absolute temperature, standard

The rating given by the University when not specified by the manufacturer (practically 100 per cent are now rated by the University) is 75 per cent of DHP_c. This test is made in rated gear.

Test G, operating maximum drawbar test, is made with the operating setting determined on the belt, and in all gears.

Test H is the ten-hour rated-load test. As described previously it is the only drawbar test on which fuel consumption is determined. It is made in rated gear.

Test J is the same as G in rated gear, except that all ballast is removed.

Test K is the same as J except that the smallest wheels and tires made available to the trade are used.

10 *Weighing.* The tractor is weighed, as tested, on a scale which is regularly inspected. The fuel tank and cooling system are filled and the weight of the operator is added.

11 *Inspecting.* Following the drawbar tests, the tractor is inspected (Fig. 5). This usually consists of removing the cylinder head and dropping the crankcase pan. The combustion chamber, pistons, rings, cylinder walls, valves, spark plugs and bearings are carefully inspected. Any indication noted while testing that part of the tractor might be questionable calls for an inspection of that part. Evidence of failure of any part is noted in the report. Photographs are made of combustion chamber deposits, burned valves and other conditions where photography is better than description, but photographs are not used in the individual reports.

12 *Drawbar Testing Equipment and Technique.* A major problem in any drawbar testing is that of securing an adjustable load. When Nebraska's program was initiated, the drawbar load was secured by removing the engine from an Illinois tractor and putting in its place a 30-hp d-c electric generator. An instrument panel with suitable controls made it possible to adjust the load. This loading unit served Nebraska many years — in fact, until it wore out. There were many commendable features about it, but the electric generator has some serious drawbacks as a drawbar load. The generator has a flywheel effect which causes the load to push the tractor in case of a sudden stop. This is overcome by an overrunning clutch.

The original loading unit was replaced by one patterned after the International Harvester Company's loading unit. It consisted of a 15-30 McCormick-Deering tractor, a gear-type pump driven from the brake-pulley shaft, plumbing sufficient to use the radiator for cooling, and throttling valves. A load imposed by a gear pump responds quickly to adjustments. The tractor as a foundation for a loading unit has many advantages. In the first place, it can be moved under its own power to the place where it is to be used. Load can be varied by shifting to any one of its several forward gears and driving the engine against compression without ignition and fuel. Load can be relieved by running the engine of the loading unit and throttling it to absorb as much as desired. Two additional loading units patterned after The Oliver Corp. unit have recently been added to the drawbar loading equipment. One is an Oliver 88 tractor and the other is a Massey-Harris 55 tractor. No additional pump equipment has been added to these tractors but a simple gate valve has been installed in the exhaust. These units have all the advantages of a tractor loading unit, namely, mobility and several gears, but in addition they can take high speed and throttling the exhaust gives a delicate control.

This change in the type of loading unit has been one of the major improvements made recently. Electrical units have been used for loading, but absorption grids carried in a mobile unit are sensitive to changes in wind and temperature and make it difficult to adjust a load delicately and have it remain as set. Pumps working against oil have been used, but they, too, are sensitive to temperature and as time passes load will drop unless given constant attention.

These new drawbar-loading units compress air. A load can be set and it will hold for hours with practically no change, a great help in the ten-hour test.

To make a drawbar test several things must be synchronized, namely, engine rpm, drawbar load, and slippage. It has been the aim to get the engine rpm within at least one-half of one per cent of rated engine speed. When testing for maximum drawbar horsepower, the engine throttle is opened wide and load added until engine rpm has been pulled down to rated rpm. A chart is then taken and computed. If the engine rpm is off too much or the slippage excessive, the test is repeated. It was not uncommon in the past to take the best part of one-half day to get satisfactory charts for one gear. Today the actual running time for satisfactory charts in one gear seldom takes more than 30 min. This, of course, does not include the time required for preparing to start a test, time to sprinkle and roll the testing course, time adding ballast and adjusting tire pressures, time to weigh the tractor, and time to planimeter the charts.

This has been made possible by having two electric tachometers actuated by a small a-c generator driven directly from the front end of the crankshaft. One of these is placed in the view of the tractor operator. The other is in the instrument car. The instrument in the dynamometer car makes it possible for the engineer to adjust the load accurately; the one before the tractor operator gives him a chance to throttle the tractor when it is necessary to do so. It is customary to make six charts in each gear and at least two must be satisfactory. It is not unusual to have all six charts usable.

13 *Reports.* Results for each tractor tested are submitted to the Nebraska State Railway Commission in a five-page report. This Commission has the responsibility of enforcing the law which requires that tractors be tested before being sold in Nebraska. If the report is satisfactory, a permit to sell is issued. These reports are then made available to the public at ten cents per copy. Anyone by paying $2 can receive all reports, also the bulletin with summary sheet published annually.

Tractor Tire Testing Equipment

By R. W. Sohl
MEMBER A.S.A.E.

THE Goodyear tractor tire testing equipment was the outgrowth of experience and equipment worked out during the cooperative tractor tire tests sponsored by the Society of Automotive Engineers, which were made during 1936 and 1937, a report of which was made at the SAE meeting at Akron in September, 1937.

R. P. Gaylord was our company's representative on this test committee and he undertook the design and construction of our test truck. This unit was completed in 1937 and was exhibited in Chicago during the ASAE winter meeting, after which it was shown to the principal tractor manufacturers. It was then driven to Arizona for winter testing operations.

Since that time the truck has been to Arizona several times and has done testing jobs for most of the tractor manufacturers as well as many hours of tractor tire testing for Goodyear.

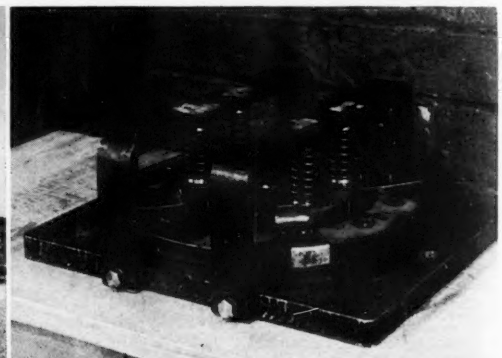
The Goodyear tractor tire testing truck is a Federal model 29, 3-4½ ton rating, with minimum draft on pavement of 300 lb. Originally a gear-type oil pump was provided as the resistance element, but this has not been used for a long time as in actual practice the test runs are so short that with the truck in gear the truck brakes are a more convenient means for the driver to hold the resistance load at a desired point.

Fig. 1 shows the Goodyear tire-testing truck coupled to a tractor in the usual manner for a tire test, with the front end of the truck shown with the drawbar connection to the truck. The drawbar is a two-inch pipe screwed into a socket on the dynamometer bell crank and terminates in a clevis at the other end coupled to the tractor. The drawbar being rigid, it permits the truck to push the tractor to get rolling resistance measurements or to get rolling distance without slip on tire tests. It also shows the ground-driven bicycle wheel which measures speed and distance.

The drawbar is connected to the vertical arm of a bell crank with the horizontal arm bearing on the main loading cell of the dynamometer. A smaller cell mounted vertically just back of the drawbar connection measures push or rolling resistance. (Continued on page 434)

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division.

R. W. SOHL is manager, tractor and implement tire development, The Goodyear Tire & Rubber Co., Akron, Ohio.



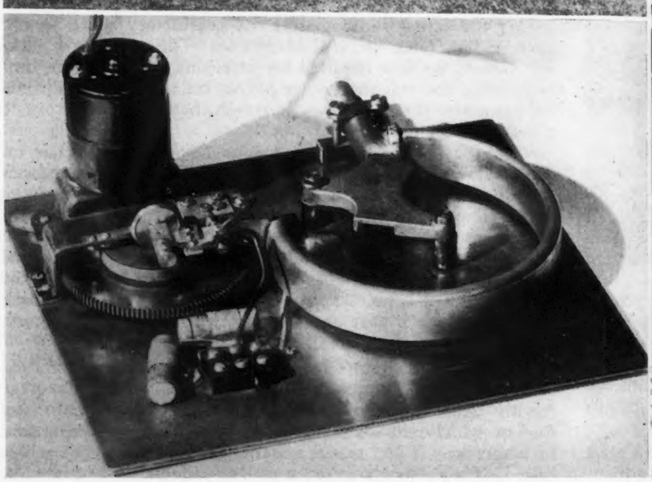


Fig. 1 (*Upper left*) The Goodyear tire-testing truck • Fig. 2 (*Upper right*) The main loading cell of the tractor dynamometer • Fig. 3 (*Lower left*) The integrator used in the tire-testing unit • Fig. 4 (*Lower right*) The instrument board in the tire-testing truck

Electric Dynamometer for Testing Tractor Uses

By J. W. Shields
MEMBER A.S.A.E.

THE United States Rubber Company designed and built a special machine to test farm tractor tires, which is located at the USDA Tillage Machinery Laboratory, at Auburn, Ala., where the company is working with the Department of Agriculture on a cooperative project to study the basic factors of tire design. The machine used for these tests is equipped with electric-type instruments for measuring the torque put into the tire by the axle and the drawbar pull delivered by the tire. It is the purpose of this paper to explain the construction and use of these instruments and to discuss the type of results secured.

A brief description of the machine of which the instruments are a part, will facilitate the explanation of their use. The machine was designed to operate on the soil plots at the Tillage Machine Laboratory. (See page 69 of AGRICULTURAL ENGINEERING, for February, 1949 for general views of the machine.) These soil plots are 20 ft wide and 250 ft long. Fig. 1 is a schematic drawing showing the general design of the tire testing machine. The machine consists of a large metal frame mounted at the four corners on truck tires which run on the I beams that separate the plots. A farm tractor is mounted inside the frame. The tractor has no front tires and the front end is carried on small rollers that run in a channel track. One rear axle has been removed and the differential blocked out so the tractor has only one tire in contact with the ground. The tractor drawbar is connected through the dynamometer to the frame of the machine. When in operation, the tractor driving the one tire pulls the machine. The amount of pull exerted is measured by the drawbar dynamometer. In order to provide a variable load for the tractor to pull against, the rear wheels are geared to a d-c electric generator which operates as a power absorption unit. By changing the resistance in the electric circuit, the load which the tractor pulls can be varied at will.

The electric drawbar dynamometer which is shown in Fig. 2 consists of two parts, the strain unit and the instrument box. Fig. 3 shows the design of the strain unit, which is really a very strong spring fitted with an electrical device for accurately indicating very small elongations. The indicating instrument consists of four basic parts, as shown in Fig. 4. An a-c generator, an impedance bridge of the Wheatstone type, a linear rectifier or demodulator, and an indicating meter. As the current in the meter is directly proportional to the elongation of the spring, the meter can be calibrated to read directly in pounds pull. By varying the shunting resistors across the meter, the sensitivity of the instrument can be changed. This

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division.

J. W. SHIELDS is farm tire specialist, the United States Rubber Co., Detroit, Mich.

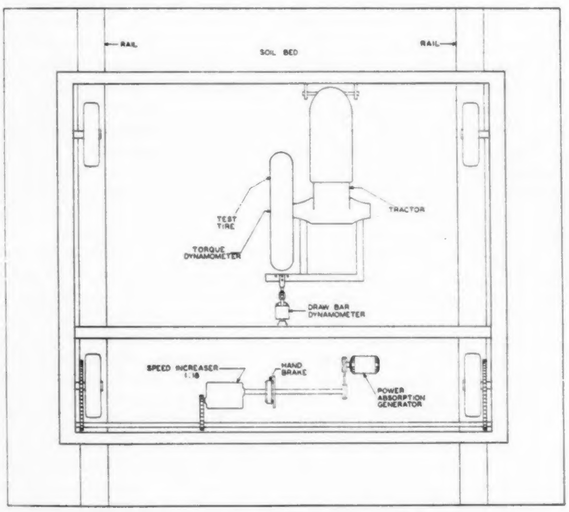


Fig. 1 A schematic drawing showing the general design of the tire testing machine

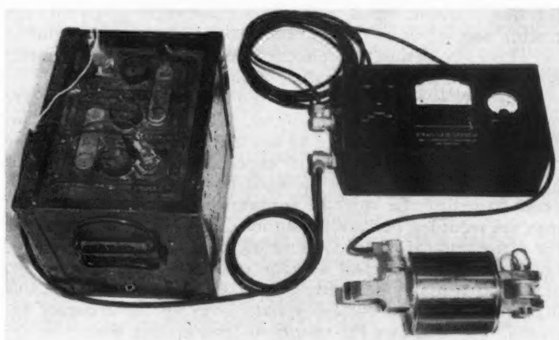


Fig. 2 The electric drawbar dynamometer

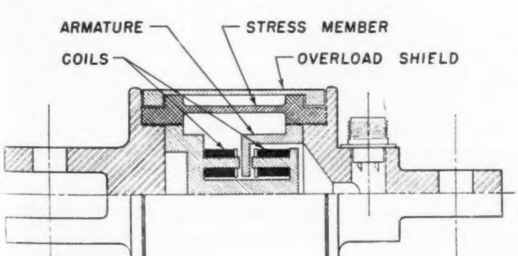


Fig. 3 This drawing shows the design of the strain unit used in the electric drawbar dynamometer

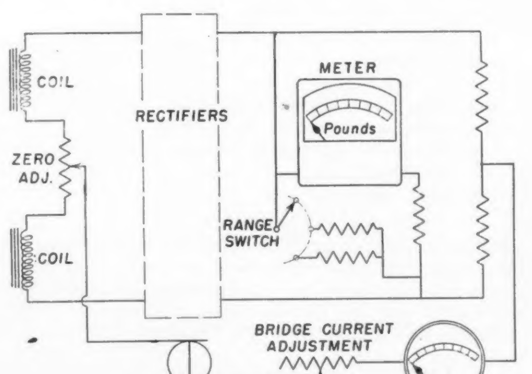


Fig. 4 This diagram shows the four basic parts of the indicating instrument

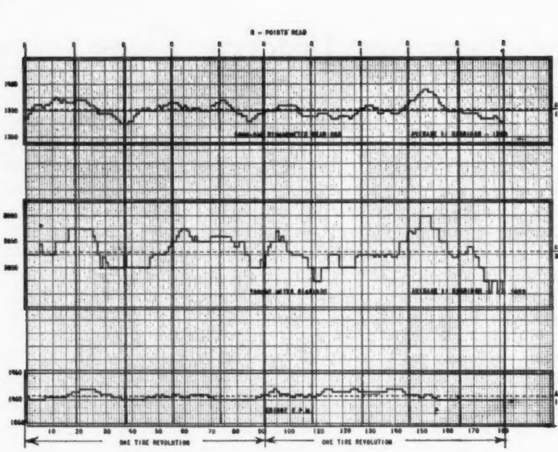


Fig. 5 The entire number of dynamometer readings on all exposures for two revolutions of the tire under test

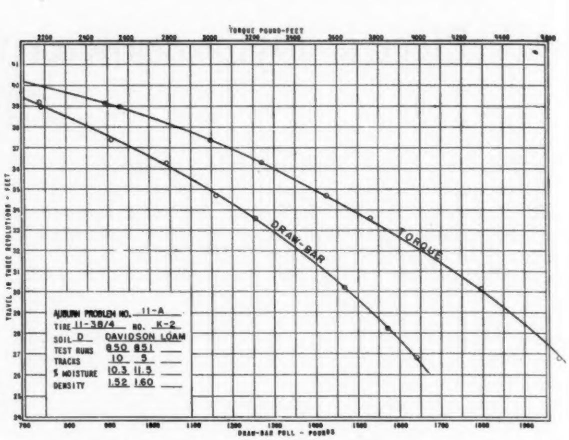


Fig. 6 A graph of the results of the tests on one tire

instrument has four ranges of 800, 2000, 4000 and 8000 lb for full-scale meter deflection. When the knob is turned to the first position, 800 lb pull on the strain unit will move the pointer completely across the scale. With the knob in the second position it would require 2000 lb pull to give full-scale reading, etc. This instrument can measure pulls from 25 to 8000 lb with a maximum error of plus or minus 1 per cent of the full-scale reading. Higher accuracy could be obtained by the use of more delicate meters.

The electric torque dynamometer was designed especially for this machine. It is mounted on the driving axle of the tractor and serves as the hub on which the wheel is mounted.

The basic design and electric hookup of the torque meter is the same as for the drawbar dynamometer.

The instrument boxes for the two dynamometers are mounted on the instrument panel. The readings of the instruments are recorded by a 16 mm electrically operated movie camera. The camera takes 16 exposures per second and approximately 94 exposures for each revolution of the tire. In order to reduce the work of reading the data, only five readings are recorded per tire revolution. Fig. 5 graphically shows the entire number of readings on all exposures for two revolutions, and how the total average compares with the average of the 10 readings generally taken. Our experience indicates that this method of recording data gives all the accuracy required. Fig. 6 shows the results of tests on one tire.

The use of the torque meter along with the drawbar dynamometer makes it possible to determine information on the following operating characteristics of a tire:

1 Travel reduction or slip at different loads
2 Tire thrust
3 Rolling resistance
4 Horsepower input for any load
5 Drawbar horsepower at any load or slip
6 Maximum drawbar horsepower
7 Travel efficiency
8 Force efficiency
9 Power or over-all efficiency

Experience has proven that the electric dynamometers and other instruments with which they are used are sufficiently accurate for this method of tire testing. They make it possible to determine the differences in operating characteristics in different soils and of tires with variations in tread design.

Tractor Tire Testing Equipment

(Continued from page 432)

Fig. 2 shows the main loading cell, which is of the diaphragm type, the diaphragm being made of cloth inserted synthetic rubber sheet material which is suitable for operating pressures up to 100 psi. A space of about 0.6 in between the cylinder and piston permits the diaphragm to bulge into this area providing increased displacement which is desirable. Lockheed brake fluid is used in the pressure system.

A large ball bearing resting in a cone-shaped cavity is the loading point in the pressure plate or piston; coiled springs return the plate to normal no-load position, and four metal clips center the piston in the cylinder.

The tractor equipment includes the drawbar with shock absorber end, slip-measuring wheels, and engine tachometer. The slip-measuring wheels are 6x2.00 pneumatic tires fastened on adjustable brackets and bearing against the sidewall of the tire. These small tires drive distributor heads which make three contacts per revolution actuating electric counters on the instrument board. The tachometer is a magneto (Western Electric model 44) connected to the power take-off shaft and wired to a voltmeter calibrated in revolutions per minute.

The distance and speed-measuring attachment consists of a 26x2¼ bicycle tire driving a magneto connected to a voltmeter graduated in miles per hour indicating the speed and registering ten counts for each revolution of the bicycle tire on an electric counter. This measures a distance of about 8 in per count.

Fig. 3 shows the integrator which we consider one of the most important items of equipment on this test unit. It consists of a horizontal disk 4 in in diameter and rotated by a constant speed 6-v motor. In contact with this disk is a 1½-in diameter vertical disk which is mounted on the free end of a Bourdon tube which is connected to the pressure line from the dynamometer cells. When pressure in the tube increases, the tube moves the vertical disk across the face of the horizontal disk towards its outer periphery, and as the large disk registers four counts for each revolution and the small disk one count per revolution, the ratio of these two counter readings represent the average pull over a given test run.

Originally a recording pressure gage with a strip chart was included in this system but was mounted vertically and never made a satisfactory record. This has since been installed horizontally in a larger test unit where it is entirely satisfactory, giving a complete record of drawbar pull, the chart being driven from the ground drive distance measuring wheel.

Fig. 4 shows the instrument board with master switch controlling all counter circuits and stop watch, load gages, engine speed indicator, travel speed indicator, stop watch and five electric counters (one missing in this photo), two for slip measuring, two for integrator, and one for distance measurement.

In the operation of this tractor tire-testing unit, a no-load run is first made by pushing the tractor with the truck and recording the various counter readings. A run is usually 100 counts of the distance-measuring wheel, about 65 to 70 ft. After this the test tractor pulls the truck, and the operator snaps the switch on when the desired test conditions are reached, then snaps off the switch and records all readings at the end of the test run. *(Continued on page 438)*

Piezometers for Ground-Water Flow Studies and Measurement of Subsoil Permeability

By R. C. Reeve and Max C. Jensen
MEMBER A.S.A.E. MEMBER A.S.A.E.

RATIONAL drainage design depends upon sound investigational procedures for obtaining basic factual data prior to construction of drainage works. In the past, drainage design has relied to a great extent upon experience and rule-of-thumb methods. In some cases these have been satisfactory, but in many instances they have resulted in ineffective drainage or complete failure. There is a growing need for improved investigational methods to supply information for sound drainage design.

The U. S. Regional Salinity Laboratory has, in recent years, studied methods and techniques for drainage appraisal in cooperation with several of the agricultural experiment stations of the eleven western states. This paper deals with studies made in Gem County, Idaho, in cooperation with the Idaho Agricultural Experiment Station, in which small-diameter piezometers were used for studying subsoil conditions and flow of underground water.

Small diameter piezometers[2, 3, 7]*—3/8-in iron pipes†—were used in this study to investigate the flow of ground water in the area of an open drain and for making permeability measurements of subsoil materials. Permeability determinations are based on the theory developed by Kirkham for flow from an open pipe into the soil below a water table[9].

BASIC LAWS

Before presenting the methods and results of these studies it is desirable to consider some of the basic laws governing flow of water through soils.

The classical experiments of Darcy, which dealt with flow of water through filter sands, form a basis for characterization of flow of liquids through porous media. The principle derived from these experiments has become known as Darcy's Law. Stated mathematically, $Q = K\,A\,dh/dl$ where Q is the quantity of water flowing in unit time through cross-sectional area, A, under a hydraulic gradient of dh/dl. The symbol dh represents the decrease in the sum of the position plus pressure head of the water normal to the flow and along a streamline of length, dl, and K is the Darcy permeability constant. Muskat[11] has used a permeability term to characterize properties of the porous media itself, which is independent of the fluid. It is related to the Darcy constant as follows: $K = k\gamma g/\mu$, where K is the permeability of Darcy as defined above; k, the permeability term used by Muskat; γ is the density of the fluid; g, the acceleration of gravity; and μ the viscosity of the fluid. The Muskat permeability term has application when dealing with comparisons of flow of fluids of varying densities and viscosities. When dealing with the flow of water through soils, variations due to gravity, viscosity, and density are usually negligible when compared to the variations encountered in the permeability of the soil itself. The Darcy constant is a simple and useful term, and it is used extensively in connection with the flow of water through soils.

The direction of ground-water flow and the hydraulic gradients associated with such flow can be determined by the use of piezometers[2,3,7]. An open tube or piezometer installed with the end terminating at any desired point below ground water level in the soil provides a means of measuring the hydraulic head in soil at that point. According to Bernoulli's theorum which assumes a uniform frictionless fluid in steady irrotational flow, the total hydraulic head at a point in a flow system is the summation of the velocity head, pressure head, and the head due to position. Since velocities associated with flow of water through soils are relatively low, the velocity head is negligible compared to the pressure head and the head due to position. The total hydraulic head at a point in the soil for practical purposes is, therefore, the sum of the pressure and position heads, which simply stated is the elevation to which water stands in an open tube referenced to sea level or some other arbitrary datum.

For interpreting hydraulic head measurements in the soil, the construction of "flow patterns" is helpful. Flow patterns are lines connecting points of equal hydraulic head, plotted on a profile section. Lines of flow, or streamlines, are everywhere normal to these lines of equal hydraulic head.

Flow patterns have been obtained in the laboratory by the electrical analogue method[1, 4] and by tracing the flow of water through a porous media with the use of colored dyes[5, 8]. In the field, flow patterns are obtained directly by measuring the hydraulic head at points in the soil[2]. It is to be pointed out that under field conditions flow is three dimensional and equal hydraulic head *surfaces* occur within the soil mass. Therefore, a flow pattern on a profile section represents only the components of flow in the plane of the profile.

Piezometers installed in groups along a selected profile, with each piezometer of a group terminating at a different depth in the soil, provide the means for obtaining the hydraulic head readings required for construction of a flow pattern. From points of measured hydraulic head, equal hydraulic head lines are located on the profile by interpolation and extrapolation. It is convenient, though not necessary, to assume linear variation between known points, and it is obvious that in regions where changes in flow occur, such as near a drain, a greater number of measured points are required to outline the pattern.

Fig. 1 (*Left*) Portable jetting equipment for installing piezometers • Fig. 2 (*Right*) Installing a piezometer by jetting

This paper was prepared expressly for AGRICULTURAL ENGINEERING, as a contribution from the Regional Salinity and Rubidoux Laboratories, U. S. Department of Agriculture, and the Idaho Agricultural Experiment Station. This work was performed in part under an allotment from the Special Research Fund authorized by Title 1 of the Bankhead-Jones Act of June 29, 1935, and in cooperation with the agricultural experiment stations of Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, Wyoming, and the Territory of Hawaii. Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 297.

R. C. REEVE is associate irrigation and drainage engineer, Regional Salinity Laboratory, USDA, Riverside, Calif., and MAX C. JENSEN is associate professor and irrigationist, Idaho Agricultural Experiment Station, Moscow.

* Superscript numbers refer to the appended bibliography.

† Nominal 3/8-in pipe has an inside diameter of approximately 1/2 in.

GEM COUNTY STUDIES

Drainage is a serious problem on much of the agricultural area in Gem County, especially in the low-lying lands close to the river. Depths to ground water of 3½ ft or less are common. In addition to flow from artesian aquifers, which are known to exist, the excessive use of water on crop lands adds materially to the drainage problem.

Studies were made of the pattern of flow of ground water in the vicinity of a deep open drain in the western end of the valley. This drain, a major outlet for the upper part of the valley, and also a wasteway for surface runoff and waste waters, was selected for study because of its depth.

Piezometer Installations. Preliminary piezometer installations were made in July, 1947. In September, 1948, additional piezometers were installed to give greater detail of flow near the drain. Piezometers were also installed at the latter date for making permeability measurements. The preliminary piezometers were installed by the driving method described by Christiansen[2]. The latter installations were made using the jetting technic[12] with portable jetting equipment transported from Riverside, Calif. in a panel truck. This equipment is shown in Fig. 1, and the setup for installing a piezometer is shown in Fig. 2.

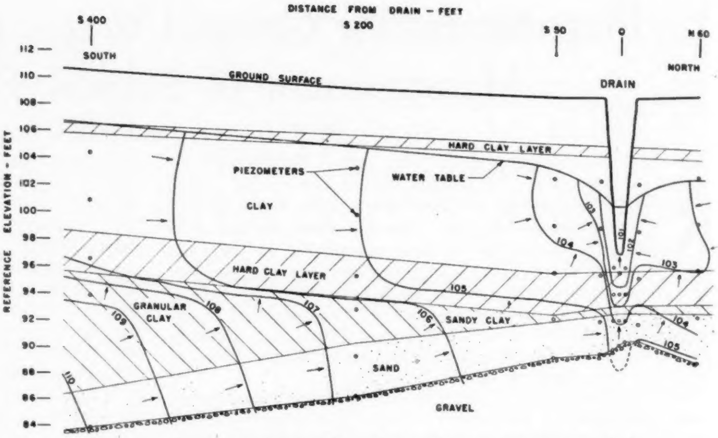


Fig. 3 Flow pattern showing flow of ground water into an open drain

The jetting method makes use of a stream of water from the end of the piezometer pipe, which provides cutting and lubricating action as the pipe is pushed into the soil. A log of the subsoil materials is obtained by this method. The "feel" of the pipe and the material carried in the return flow around the outside of the pipe give a qualitative measure of the material penetrated. The coarseness of sands can be judged by the grittiness of the feel on the pipe, and clays exhibit a hard feel with progress usually being slow. In silts, the pipe gives a somewhat smoother feel than in clays and penetration is more rapid. After the pipes are jetted to the desired depth, the jetting stream is immediately shut off so that the material in suspension in the annular space around the pipe settles back around the pipe. This is usually sufficient to seal the jetted hole around the pipe and thus prevent leakage from one level to another. Difficulty was experienced in unconsolidated coarse sands due to the jetted material not flushing from around the piezometer and as a result "freezing" the pipe. Penetration could not be made in gravel.

Six groups of piezometers were installed in a line at approximately 75 deg with the open drain (along a fence line) at distances from the drain of 14½, 50, 200, and 400 ft on the south and 14½ and 60 ft on the north. Each group consisted of four piezometers of lengths, 7, 10½, 14, and 17½ ft. One additional piezometer in each group was installed to the top of the gravel stratum, which was at a depth of 18 ft at the drain and 26½ ft at 400 ft south. The tops of the pipes in each group were cut off at the same level, about one foot above ground surface. After the pipes were in position, they were flushed with a small jet of water from a plastic flushing tube pushed down inside the pipe. A cavity was formed below each pipe in the flushing process to insure free movement of ground water into the pipe. The sensitivity of the piezometers to ground-water changes was checked by filling the pipes with water and noting the rate of drop of the water level. Where rates were slow, piezometers were reflushed to make sure the soil cavity at the bottom of the piezometer was not sealed with sediment.

In addition, three groups of piezometers were installed in the bottom of the drain, each consisting of pipes 5, 7, 9, and 12 ft in length. One group was put at the drain center line, and one group at each of the water surface edges 4½ ft from the center line. The depths of piezometers are indicated by circles on the flow patterns, Figs. 3 and 4. The elevations of all pipes were determined with reference to an arbitrary bench mark to the nearest 0.01 ft and of the ground surface at each location to the nearest 0.1 ft. Water levels were measured with an electrical sounder similar to the one described by Christiansen and Donnan[2, 3].

Permeability Measurements Using Piezometers. Permeability measurements were made with piezometers by Kirkham[10] in which the openings at the bottom of the pipes were made with a flushing tube. He found that the size and shape of the hole could not be controlled adequately with this method of construction and that the permeability obtained was dependent upon the amount of flushing.

An augering method (described below) was used in these studies to obtain a uniform size and shape of opening at the bottom of the pipe as shown in Fig. 5.

Eight piezometers were installed in the drain for the express purpose of making permeability measurements. The pipes were jetted to within about 1 to 1½ ft of the desired depth and then set to grade by alternately augering the soil from beneath the pipe (with a 7/16-in diameter auger used inside the pipe) and driving. The pipe was driven in this manner in 3-in increments. This procedure was followed to minimize compaction of the soil beneath the pipe that results when the pipe is installed by driving alone.

Six of the permeability piezometers were installed to terminate at a depth of 3.0 ft below the bottom of the drain (four along the center line and one on either side 4½ ft from the center line). Two were installed to a depth of 1.0 ft below the bottom of the drain 4½ ft out and on either side of the center line.

Special precautions were taken to control uniformly the size and shape of the openings made at the bottom of the tubes for the permeability measurements. Each cavity was made by augering a hole 7/16 x 3 in beyond the piezometer bottom. In order to minimize the sealing effect of suspended sediment as encountered by Frevert[4] in studies used on 6 and 8-in cylinders at shallower depths, the pipe and hole were flushed free of suspended material with a very low velocity jet from a plastic tube placed inside the pipe to the bottom.

The rate of intake of water was determined by measuring the rate of drop of water level in a glass tube 4.0 mm in diameter placed in the top of the pipe (Fig. 5). Permeability values were calculated using the equation for the variable-head condition derived by Kirkham[9]:

$$k = \frac{\pi \mu r^2 \ln (h_1/h_2)}{\gamma g A(R,d) (t_2 - t_1)}$$

where k = permeability of the soil
μ = viscosity of the soil water
γ = density of the soil water
g = acceleration of gravity
r = radius of the standpipe
d = depth of test hole below water table
h_1 = effective head at time t_1

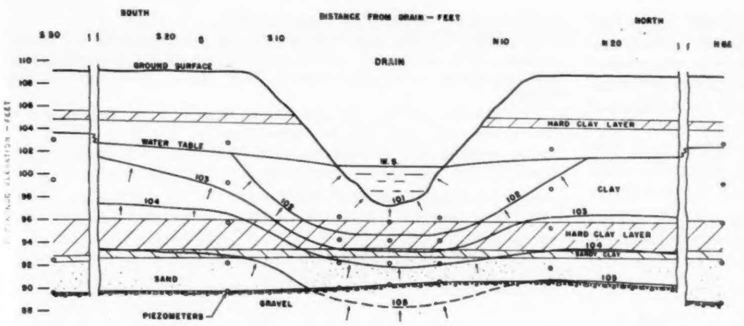


Fig. 4 An amplified flow pattern showing the flow of ground water near an open drain

h_2 = effective head at time t_2
R = radius of test hole at bottom of the pipe
L = length of the test hole at bottom of the pipe
ln = natural logarithm
$A(R, d)$ = function of the radius, R of the test hole at the end of the pipe, and the depth of the test hole below the water table, d. Refer to [9] for discussion of this function.
$t_2 - t_1$ = the time for the water level to drop from h_1 to h_2.

Using the Darcy permeability constant, where $K = k\gamma g/\mu$ this equation becomes

$$K = \frac{\pi r^2 \ln (h_1/h_2)}{A(R, d)\ (t_2 - t_1)}$$

The function $A(R, d)$ can be determined empirically for various shapes and sizes of openings at the bottom of the pipe by the use of the electrical analogue method[4, 9]. For the case of a cylindrical opening at the bottom of the pipe, as was used in these tests, another parameter L (defined above) is involved and the expression $A(R, d)$ becomes $A(R, d, L)$. This function for a 7/16 x 3-in hole beneath a pipe was determined by Luthin‡ at Iowa State College, using the electrical analogue method. He found that the function $A(R, d, L)$ for this size cavity was equal to 7.36 in for values of d greater than 12 in.

Permeability Measurements Using Seepage Meter. Permeability measurements were made of the soil constituting the bottom of the drain with the seepage meter developed by Christiansen and Moore at the Salinity Laboratory and described by Israelsen and Reeve[6]. The rate of inflow into the circular section isolated by the meter was determined by the increase in weight of a plastic bag connected to the enclosed section with a rubber tube, in a given period of time. The isolated section was maintained at the same head as the rest of the drain bottom by submerging the plastic bag in the water in the drain.

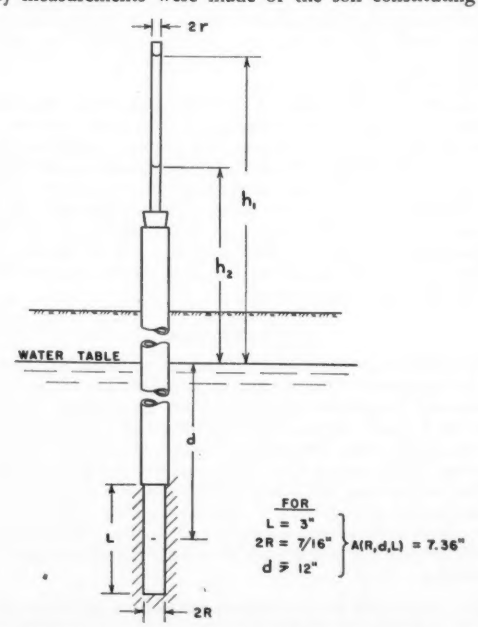


Fig. 5 Permeability measurements of subsoil materials using piezometers

Inflow determinations were made by this method at distances of 10, 15, and 40 ft from the piezometer locations. The permeability values for these tests were calculated by using the hydraulic gradient as determined with the piezometers.

RESULTS

Fig. 3 shows the flow pattern near the open drain, extending a distance of 400 ft to the south, and 60 ft to the north of the drain. An amplification of the pattern immediately around the drain is shown in Fig. 4. It is to be noted that in Fig. 3 the horizontal scale is ten times that of the vertical, whereas the scale in Fig. 4 is one to one.

Superimposed on the flow pattern is a log of the subsoils to a depth of about 15 ft. The topsoil, classified as the Reed series, is underlain with sand and gravel. Hard layers occurred within the overlying clay soil, which were difficult to jet through with piezometers. These layers seemed to be caliche or some other compact material. The underlying sand and gravel is typical of the Reed series and it is likely that these layers have considerable lateral extension.

Referring to the flow pattern, it can be seen that the water in the sand and gravel is confined by the overlying clay soils, and that water is flowing both upward and laterally in the direction of the land slope. Flow, indicated by the arrows, is at right angles to the equal hydraulic head lines. In addition to water flowing into the area laterally in the sand and gravel strata, water is added to the ground water by irrigations occuring on the surface.

The fact that the equal hydraulic head lines are depressed around the drain is evidence that some ground water is being intercepted by the drain. An estimate of the quantity of water flowing into the drain can be made if the permeability of the soil is known. As would be expected, the configuration of the equal hydraulic head lines immediately around the drain is similar to that of the drain bottom. The line formed by the intersection of the plane of the profile with the submerged portion of the bottom of the drain is an equal hydraulic head line, the value for which is equal to the elevation of the water surface in the drain.

It should be pointed out that the flow pattern represents the state of flow at a given time. These readings were taken September 4, 1948. The pattern will change as the inflow or outflow conditions of the area or the drain change. If the pattern as shown represents a steady state of flow, and water movement above the water table is negligible, the water table constitutes a streamline, in which event equal hydraulic head lines will be at right angles to it. If, however, the flow is not steady, the equal hydraulic head lines will intersect the water table at an angle depending upon whether the water table is rising or subsiding and upon water flow in the soil above the water table. The data in this case seem to indicate that the water table is rising, which may be the result of the irrigation taking place on the adjacent farm.

The position of the water table was located by extrapolation. Theoretically, the position of the water table can be measured only if the bottom of the piezometer coincides with the water level, except for static conditions or the case where

‡ J. N. Luthin kindly supplied this information in advance of publication of the paper: "A piezometer method for measurement of the permeability of soil below a water table."

flow is horizontal. It is obvious that under static conditions the hydraulic head will be the same at all points throughout the system and the position of the water table is determined by measurement at any point below the water table. For horizontal flow, the position of the water table can be determined by measuring hydraulic head at any point along a vertical section. Where either upward or downward components of flow occur, the bottom of the pipe must coincide with the water level in order to measure the water table position correctly.

TABLE 1. PERMEABILITY DETERMINATIONS, USING PIEZOMETERS AND SEEPAGE METER, OF MATERIALS AT THE BOTTON OF AN OPEN DRAIN

Location	Depth below bottom of drain (ft)	Permeability (K) Kirkham method in/hr	Seepage meter in/hr
CL Drain	3.0	0.014	
" "	3.0	0.012	
" "	3.0	0.034	
" "	3.0	0.006	
" "	3.0	0.006	
N 4.5 ft	3.0	0.021	
S 4.5 ft	3.0	0.031	
		Ave. 0.020	
N 4.5 ft	1.0	0.011	
S 4.5 ft	1.0	0.002	
CL Drain	On Bottom		0.008
" "	On Bottom		0.009
" "	On Bottom		0.013
			Ave. 0.010

Table 1 gives the permeability values obtained by the Kirkham method and by the use of the seepage meter. The average permeability of the hard clay layer at 3 ft depth below the bottom of the drain is 0.020 in per hr and the average permeability of the bottom of the drain as determined with the seepage meter is 0.010 in per hr. Using the latter value of permeability, the average hydraulic gradient, 0.23 (determined graphically from the piezometer data, Fig. 4), and the measured periphery of the bottom of the drain, 13.2 ft, the quantity of flow into the drain is 7.0×10^{-5} cfs per 100 ft of drain. Thus, a drain 280 mi in length would be required to develop a flow of 1 cfs. It is evident from this that the permeability of the material in which the drain is constructed is so low that the inflow into the drain from the ground water is negligible. The stream carried by the drain (Fig. 4) actually comes from surface waste and runoff. Very little of the flow is intercepted from the ground water because of the impermeable clays in which the drain is constructed.

Water flowed freely into the drain from the piezometers installed into the sand and gravel. The flows ranged from 0.35 to 1.65 gpm for a head differential of 1 ft. From this it is evident that an appreciable flow into the drain could be developed by drilling through the clay and tapping the sand and gravel stratum with a vertical drainage channel.

Referring to Fig. 3 it is noted that at a distance of from between 200 and 400 ft south of the drain, water is flowing laterally in both the sand and the clay. The hydraulic gradient in the sand is approximately twice that in the clay as evidenced by the closer spacing of the hydraulic head lines. If the permeability of the clay at this point is considered equal to that determined in the bottom of the drain with the seepage meter, 0.010 in per hr, the ratio of the quantity of flow per unit area in the sand (permeability of the sand equals 60 in per hr as determined in the laboratory) to that in the clay is 12,000 to 1. In other words, the quantity of water flowing laterally in the clay, in the direction of the land slope, is only 1/12,000 of that flowing in the sand.

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Tractor Tire Testing Equipment

(Continued from page 434)

From these readings of time, distance, average pull, and tire slip can be plotted any desired combination of speed, pull slip, and horsepower for a series of runs over a range of loads within the ability of the equipment.

A calibrated Chatillon spring-type dynamometer is carried in the truck so that the drawbar pull gage and integrator may be checked when desired. Top speed is 6 mph, the limiting factor being electric counters which will not count more than 700 counts per minute with accuracy; however, this has not been detrimental for usual testing operations.

Higher speeds could be handled by reducing the number of contacts per revolution. This would increase the distance travelled per count and require longer test runs for the same accuracy of measurement.

Engineering Frontiers

(Continued from page 415)

in dealing with factors still in the realm of unknowns, uncontrolled variables, unpredictable forces, and the vagaries of the human mind? Who better than engineers should see how far and how fast the boundaries of engineering may best be extended in the interest of man?

Where is there a field richer than agriculture for the application of engineering techniques; more important to man than his food supply; influenced by a wider range of natural law; more challenging in complex quantitative relationships beyond the range of previous engineering experience; or offering greater opportunity for vision in the application of engineering to the present service and future destiny of mankind? It is a field in which an alert appreciation of distant possibilities can help to guide our next immediate steps in the direction of engineering progress.

A Profession

ALL members of a profession who are seriously and earnestly concerned with rendering a maximum of service to society will cooperate generously with each other. They are aware of a social responsibility to the profession. Such members invariably bind themselves together in technical and professional groups whose chief purposes are to advance both the profession and the individual interests of the members. It is an obligation of engineers to help each other and to present before their professional societies such papers and discussions as will extend the knowledge of their work and assist other co-workers.

From "The Social Responsibility of the Engineering Profession," by Blake R. Van Lear, in "Engineering Experiment Station News," Ohio State University (Columbus), June, 1949.

Performance Characteristics of Long Hay Blowers

By Alfred D. Longhouse
MEMBER A.S.A.E.

BLOWING long hay into the mow is one of the newer methods of putting it in storage. The first hay blowers were old wind stackers taken from obsolete and worn-out threshing machines. Then in 1945 two small farm machinery companies in New York made the first models of the present-day hay blowers. A year later another manufacturer entered the field, but because of the shortage of steel, only a few units have been made. Even at this writing, the total output for this year probably will not exceed 600 units.

This report deals with a study that was started in 1945, to determine some of the functional requirements of long hay blowers. It should be kept in mind that this study was conducted to secure general performance characteristics of these blowers, rather than detailed information. Time permitted only four tests on each machine, or one test for each of the four different constant speeds. This would be insufficient evidence upon which to draw detailed conclusions, but the information obtained indicates some of the general characteristics of a successful hay blower.

The early part of the study centered around field operations. Information was obtained for a large number of used and new thresher blowers and the three commercial hay blowers under actual operating conditions, blowing all kinds of hay. With these records and experiences in the field, it was possible to make some important observations and draw general conclusions.

Laboratory Tests and Equipment. During the summer of 1946 the three commercially manufactured hay blowers and used and new thresher blowers were tested for performance characteristics in the agricultural engineering laboratories at Cornell University. Besides these, a blower was built in the laboratory to make additional studies which were not possible with the other blowers. All told, twelve blowers were tested at four different constant speeds, ranging from 500 to 1250 rpm.

A 16-in by 18-ft wind tunnel was constructed which conformed as closely as possible to the requirements set forth in the Standard Test Code for Centrifugal and Axial Fans by the National Association of Fan Manufacturers. The pitot tube traverse was 13.33 ft or 7½ diameters from the fan and the air straightener was 8 ft or 6 diameters from the fan. Each division of the air straightener was approximately 10 per cent of the duct diameter. A standard pitot tube and a 2-in inclined draft gage was used to obtain most of the pressures. Pressures over 2 in (water gage) were first recorded by an airplane air-speed gage. These readings were converted to equivalent inches of water. Twenty traverse points (ten horizontally and ten vertically) were recorded for each test run. Seven thin-plate orifices were used to throttle the flow of air from free delivery to static-no-delivery at the discharge end of the duct.

Total pressure, P_t, was measured by the impact tube. The velocity pressure, P_v, was measured from the differential reading between impact tube and static tube. Then the velocity pressure, P_v, was corrected to the velocity pressure corresponding to the fan outlet. Likewise, the total pressure, P_t, loss due to duct friction and air straightener was added to the total pressure corresponding to the fan outlet. Static pressure, P_s, was obtained by subtracting the velocity pressure, P_v, from the total pressure, P_t. All pressures were corrected to standard air conditions.

Blowers 2 and 2A are homemade hay blowers. They have about as many objectional features as any of the hay blowers tested. The housing and pipe assembly are the same for both blowers. The only difference between the two is the size and construction of the fan. Blower 2 has a 9x40-in flat, four-blade fan. Blower 2A has a 7x42-in flat, 4-blade fan, but the front of each blade has a 1½-in, right-angle edge bent forward in the direction of rotation. The purpose of this bend was to strengthen the blade.

To the casual observer, blower 2A with the larger fan should seem capable of doing more work and, being better fitted to the housing size, should be more efficient. On the contrary, the over-all performance of this longer fan is poorer than that of blower 2. This is principally due to the bent front edges of the blades. Air drawn in over these edges, which are 1½ in high, sets up eddy currents disturbing the free movement of air over the blades to their periphery. This turbulence of the air in the blower reduces its efficiency and air delivery.

The blower has a circular housing instead of a properly designed scroll housing as generally used in commercial blowers. Furthermore, the clearance at the fan tips in four positions in the housing are opposite to fan engineering practice. Beginning at the cutoff, where the fan blade passes the outlet, the clearance between the tip of the blade and the housing should continually increase around the housing to the outlet. This blower has approximately 2 in clearance at the cutoff and decreases to one inch at the bottom of the housing.

Fig. 1 is a graphical representation of the fan characteristics curves of Blower 2A from free delivery to static-no-

This paper was presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Guelph, Ontario, September, 1948. It is based on a thesis for a PhD degree submitted by the author to the graduate school of Cornell University in September, 1947.

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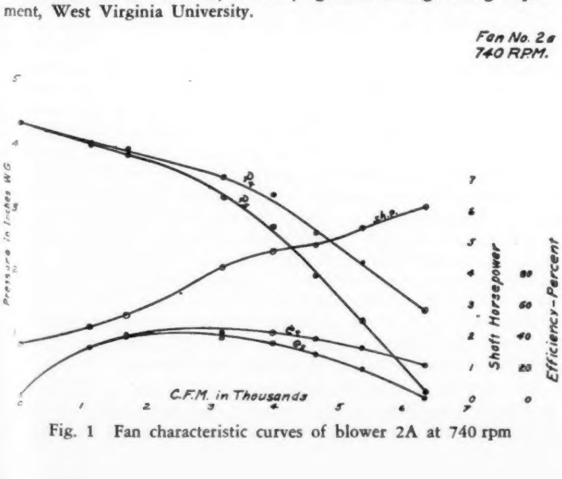

Fig. 1 Fan characteristic curves of blower 2A at 740 rpm

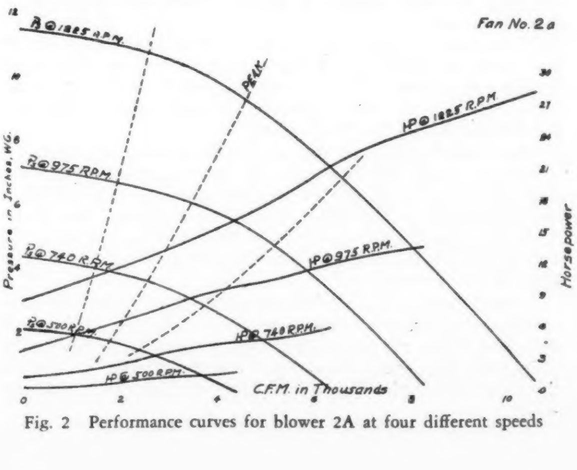

Fig. 2 Performance curves for blower 2A at four different speeds

delivery at 740 rpm. At free delivery this blower delivered 6346 cfm at 0.16 in of water, static pressure. At static-no-delivery the total pressure and static pressure were 4.33 in of water. At free delivery, the shaft horsepower is 6.27, the mechanical efficiency is 23 per cent, and the static efficiency is 2.5 per cent. At peak static efficiency of 42 per cent, the blower delivered approximately 2500 cfm and required 3.45 hp. The "hump" in the horsepower curve is characteristic of this blower at all speeds.

Performance curves for blower 2A have been plotted graphically on Fig. 2 with the values of the cubic feet of air per minute along the abscissa and the static pressure and horsepower values along the ordinate from the free delivery to static-no-delivery. Broken lines are static pressure curves. The center line passes through the point of peak static efficiency for each of the constant speeds. The other two curves represent a 5 per cent drop from peak static efficiency. Distance between these two curves increases as the speed increases. Shaft horsepower at peak static efficiency ranges from 1.0 hp at 500 rpm to 16.80 hp at 1225 rpm. At 1000 rpm this blower delivers approximately 3600 cfm at peak static efficiency and requires 9.90 hp. The static pressure under these conditions is 6.30 in of water.

The system characteristics for blowers 2 and 2A have been plotted together in Fig. 3. Although fan 2A is 2 in greater in diameter, it did not perform so efficiently as the first fan. A study of the system characteristics (Fig. 3) reveals less static pressure and lower rate of delivery for the larger fan. A pipe equivalent of 20 ft was used to determine the systems' charactertistics. The intersection of these lines with the static pressure curves for each fan indicated the static pressure and cubic feet of air per minute that may be delivered through each system.

These data fairly well represent the characteristics for fan 2 which was discarded by the owner, except that its peak mechanical efficiency was 10 per cent higher than for fan 2A.

Most of the blowers in this study have straight-blade or paddle-wheel type fans, but the casings or housings vary greatly. Likewise, the exhaust systems vary considerably. Some have straight, rigid piping while others use flexible elbows and extension pipes.

IMPORTANCE OF THE FAN INLET

Fan Inlet. The fan inlet is important. An inlet which is too large may cut down on the efficiency of the blower because of the recirculation and the resulting turbulence of the air about the inlet. An inlet too small will not allow sufficient air to enter the blower.

The size and shape of the housing inlet and fan proportions are subject to wide variations. One means of determining the size of the inlet is the ratio of its diameter to the diameter of the fan. For the blowers tested or observed, the ratio varies from 0.32:1 for blower 13, which was homemade, to 0.78:1 for blower 3. Incidentally, these two blowers which represent the two extremes, are the only two blowers whose inlet-fan diameter ratios are outside the range used in commercial practice.

According to Mark's Handbook for Mechanical Engineers[1]* this ratio for straight-blade fans should not be less than 0.50 or more than 0.70. For backward-curved fans the ratio may be as high as 0.75. All of the other blowers tested or observed have ratios within the limits described.

Fan Housing Design. Modern housing construction uses a scroll-type design for high efficiency blowers. Hay blowers, in order to "conform to the law of the constancy of the moment of momentum circulation," must have spiral or scroll-housings, which are logarithmic. The blowers in this study vary greatly in the shape of housing and in the size and position of the outlet.

Fan Wheels. Fan wheel proportions are subject to wide variations. Stresses in material or the combination of specified duty and speed are often determining factors. According to Mark[1] the significant proportions are the number of blades, the ratio of the inlet diameter to fan wheel diameter, and the ratio of axial width to diameter. This latter ratio is important only as a maximum. Reduced widths are always allowable. The ratio should not exceed 0.38 to 1.48 for paddle-wheel fans.

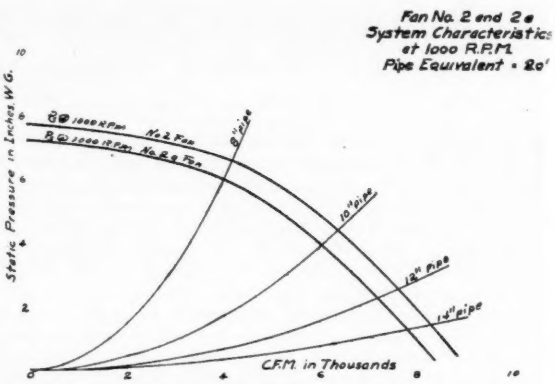

Fig. 3 System characteristics for blowers 2 and 2A at 1000 rpm

Hay blowers with fans not greater than 8½x40 or 7½x42 in can be run at 1000 rpm with the average*farm tractor. Smaller blowers like the blower 3 with an 8x36-in fan are just as acceptable, the only difference being in capacity to handle hay. The latter blower cannot be expected to put up as much hay per hour as the larger blower.

Cutoff Design. The clearance between the cutoff and the tip of the fan blade is important. It is in this area that the transition from the spiral flow in the housing to the straight-line flow in the connected duct or pipe takes place.

According to Mark[1], a fan of 3 ft diameter should have a clearance of 3 to 5 in at the nearest point. Larger blowers require a greater distance and smaller wheels permit less.

Exact proportion is not necessary as noise, rather than efficiency, is the determining factor in fixing this dimension. Assuming these conditions to be applicable to hay blowers, sufficient space should be allowed at the cutoff to permit hay clinging to the fan tip to pass without plugging. All of the threshing machines tested or observed have one inch or less clearance at the cutoff. The commercial hay blowers and the homemade hay blowers have considerably more clearance in most cases. Generally speaking, plugging was more frequent in the blowers with the least clearance. This study shows that the inner edge or cutoff of the fan outlet may be located close to the center line of the fan or extend as much as 28 deg into the outlet for successful operation and the spiral band of the housing swept from this point around to form the outlet, the sides of the housing being plain and parallel. A clearance of 2 in is ample.

Fan Outlet. The size of the outlet is determined in a large measure by the size of pipe or system used. As a rule, blowers that have handled hay successfully have exhaust pipes about the same diameter as the width of the housing. Frequently they are larger. Often the area of the outlet in the housing is twice the area of the pipe, and a transition piece is used to transform the square or rectangular opening in the housing to a circular opening for the pipe. Blowers having a sharp reduction from one end of the transition piece to the other have a tendency to plug more often. In the conventional thresher blowers, transition pieces are used as a means of cleaning out a plugged machine. In many cases the designer has ignored sound design features when making this transition piece. Consequently experiment shows that several of these machines have low mechanical efficiency because of turbulence and loss of air around and through the transition piece. Only one of the three commercially manufactured hay blowers uses a transition piece, and this machine has the lowest mechanical efficiency rating of them all.

Feed Table. One of the greatest objections to the use of thresher blowers as hay blowers is the steep, sloping table commonly found on them. Hay dropped on these steep tables

* Superscript numbers refer to the appended bibliography.

tends not only to be sucked in by the action of the air through the blower, but also by gravity. The combination of these two factors make the blower operate unevenly and it is more subject to plugging. Experiment shows that these tables should be nearly horizontal and as low as possible. Steep feed tables are more difficult to pitch hay onto because of their height above the ground.

Clearances. It was found in this study that hay blowers must have sufficient clearance between the fan and the cutoff and between the inlet side of the housing and the fan, to permit free movement of the hay. Long, stringy material, like hay, has a tendency to cling together, so if there is not enough space or clearance, hay will wedge between the fan and the housing and cause plugging.

The author is at a loss to see why thresher blowers have been made with such close clearances at the cutoff because wider clearances up to 5 in for a 36-in fan do not affect the efficiency of the fan and do eliminate noise[3]. This study shows that thresher blowers would plug more often than hay blowers, which have much greater clearance at the cutoff. Thresher blowers usually have less than one inch clearance and two of the three commercially manufactured hay blowers have a clearance of 2 in or more.

CUTOFF CLEARANCE DOES NOT AFFECT EFFICIENCY

While the clearance at the cutoff does not materially affect the efficiency of the blower, clearance between the inlet side of the housing and the fan will affect its performance. But enough clearance is necessary to prevent undue plugging. One of the tests with blower 8 was to determine how much clearance was permissible without seriously affecting the performance of the blower. As the clearance was increased from 1/4 in (fan 8A) to 1½ in (fan 8E), the quantity of air dropped from 8,300 cfm to 8,050 cfm and the static pressure dropped from 2.95 to 2.78 in of water. When fan 8E was used with 3¼ in clearance in the same housing, the quantity of air dropped from 8,300 to 7,460 cfm, and the static pressure dropped from 2.95 to 2.35 in of water. Even with this relatively large clearance, which is more than necessary, there is only a 10 per cent loss in volume and a 15 per cent loss of static pressure. Experiment shows that this clearance should be between 2 and 3 in.

Summary of Performance Characteristics. At peak static efficiency at 1,000 rpm there seems to be no definite correlation between the efficiency of the blower and the type of housing used, either scroll or circular. Some of the blowers with circular housings, such as blowers 2 and 3, have higher peak static efficiency percentages than the blowers with scroll housings. When averages are taken, the scroll housing seems to be the better. Nine scroll housings have an average peak static efficiency of 51 per cent and the three circular housings average 46 per cent at 1000 rpm. Shaft horsepower requirements at 1000 rpm range from 5.40 for the 34-in fan 7 to 22 hp for the 43-in fan 1. This wide range in horsepower requirement is due to one of the fundamental laws of mathematics, in that shaft horsepower varies as the square of the diameter of the fan.

Peak Static Efficiency. Fan 1, which is the largest, requires 1.6 hp at 500 rpm and 23 hp at 1235 rpm peak static efficiency. These power values increase rapidly in relation to speed because shaft horsepower varies as the cube of the speed.

The quantity of air delivered per minute at 1000 rpm, peak static efficiency, is probably one of the best measuring sticks for judging the relative capacity of the blowers. Blower 7, the smallest, delivers 3000 cfm, and blower 1 delivers 5600 cfm. The considerable range in cubic feet of air per minute delivered by these blowers does not mean one is better than the other. It merely means that fans delivering less air per minute will not handle as much hay per hour as fans delivering more air per minute. At the low extreme the supply of air may be so low that hay must be metered or sifted into the blower. At the other extreme, there may be an ample supply of air and hay, which is too much for the average farm tractor. Such is the case of blower 1. The quantity of air delivered by the fan ranges from 1700 cfm at 500 rpm to 3700 cfm at 1235 rpm for the smallest blower, and 3000 cfm at 500 rpm to 7000 cfm at 1235 rpm for the larger blower.

From an engineering standpoint, averages do not mean much, but it may be interesting to some that the data for the blowers in this study show an average peak static efficiency of 49 per cent and a demand of 9.65 shaft horsepower to deliver 4300 cfm at 1000 rpm peak static efficiency.

System Characteristics. The size of the pipe is of vital importance to the design of a successful hay blower. Hay leaving the housing of the blower must be carried through the pipe by the air and unless there is sufficient volume, velocity, and static pressure available to carry the hay, it will fall out of the air stream and cause plugging. Field tests and field survey studies show that for economic operation, the average 40-in fan must run at approximately 1000 rpm in order to handle hay effectively. Smaller fans must run at higher speeds and larger fans at lower speeds, but regardless of the size of fan, the peripheral speed of the fan should be about 10,000 fpm. When this peripheral speed is obtained there should be at least 2 in of static pressure and a velocity of 8500 to 10,000 fpm in the pipe. Generally then, the ratio of the velocity of the air in the pipe to the peripheral speed of the fan will be more than 0.80. Systems having an air velocity under 80 per cent of the peripheral speed of the fan will not have sufficient velocity to carry the hay through the pipe. Also there will not be sufficient static pressure to force the hay through the pipe. When the 43-in fan 1 was replaced by a 40-in fan in the blower housing, there was a drop of 0.74 in of static pressure and a drop of 1735 fpm of velocity. By reducing the size of the pipe from 14 in to 12 in, the static pressure would then be 2.82 in and the velocity of the air would be 10,435 fpm. The smaller fans, like blowers 7 and 3 must run faster than 1000 rpm to develop the required velocity and static pressure or they must be equipped with a smaller pipe to obtain desired results. In some cases it is more desirable to speed up the fan rather than reduce the size of the pipe if the power requirements are not too great for the higher speed since tonnage varies as the square of the pipe diameter changes. Tonnage also varies as the cube of the velocity change. At the same time, it must be kept in mind that as the speed of the fan varies, the shaft horsepower is cubed. All of these factors must be considered when designing a hay blower, which can be operated with the farm tractor without metering the hay.

WHAT SUMMATION OF STUDY INDICATED

In the summation, this study indicated that for average farm tractor operation, the hay blower should have an 8¼x 40-in (or its equivalent in horsepower requirement), straight-blade or backward-curved fan mounted in a logarithmic spiral housing with 2 in clearance at the cutoff and at the inlet between the fan and the housing. The diameter of the inlet should be not less than 0.50 or more than 0.70 of the diameter of the fan.

The feed table should be as low as possible and nearly horizontal. The pipe assembly should be 12 in in diameter with a swivel, flexibility-elbow, extention pipe and hood which can be controlled from the ground. Some experiments have indicated that a hay blower should have at least 2 in static pressure in the system at free delivery. A 12-in pipe would be recommended for all five fans.

Blowers 1A, 3 and 7 which have less than 2 in static pressure at free delivery, plugged more easily than the others and more sifting or metering of the hay was required.

Also the peripheral velocity of the fan was considerably less than the 10,000 fpm which experiment indicated was needed.

Blower 4 handled partially cured hay better with a 11-in pipe than with a 13-in pipe. When buying this blower, farmers had their choice of the two systems.

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The Airplane as an Agricultural Implement

By E. W. Lehmann

FELLOW A.S.A.E.

THE airplane as an implement in agriculture is not a new idea. However, most farmers in the United States have had little contact with its use until recent years, although farmers of the South and Southwest have used it for dusting cotton, for planting cover crops, and other operations for many years. The need for research in making the airplane more effective in agriculture is generally recognized.

The mutual interest of manufacturers, custom operators, and agricultural experiment station workers prompts the suggestion that much can be accomplished through cooperative effort in the solution of many basic problems. In new agricultural developments, new research must compete with the demands of existing projects for state and federal funds, as well as for funds from other sources.

Some comparative studies have been made already at the University of Illinois, comparing the airplane as a means of applying insecticide material with ground machinery. It is reported that airplane dusting has resulted in 50 to 70 per cent borer control, with one or two applications.

There are other active projects at the University of Illinois which are concerned with spray application and equipment problems. The departments of agricultural engineering, agronomy, horticulture, and entomology, the Illinois Natural History Survey, and the Institute of Aeronautics are cooperating on a project to evaluate the effectiveness of aircraft spraying of insecticides and herbicides.

The USDA Office of Experiment Stations has informed me of active projects in a number of states, including Idaho, Louisiana, Mississippi, Rhode Island, and West Virginia. There are no doubt active projects in other states. Some further information was secured from a few of the states in which the airplane has been most used; I refer particularly to Texas and California.

There is little doubt in my mind that at this time the Civil Aeronautics Commission, the manufacturers of airplanes and equipment, and custom operators are making the greatest contributions toward the successful use of the airplane in agriculture. Every week we hear of new airports and landing strips being certified and pilots registered. We also hear of new developments in the form of attachments, new type nozzles and pumping units.

For effective results, whether the job is done by a manufacturer, a custom operator, a farmer, or an experiment station worker, certain fundamental principles and requirements must be considered.

First, the airplane, when finally developed as an agricultural implement, must be functional and do the job for which it is designed and constructed. The problem is a complex one, and the basis for design is not completely understood. It is quite different from the design of ground machines, because many factors cannot be brought under control. It is only by applying known design principles and by making field tests that a satisfactory unit can be developed.

The second important requirement is that the unit be well constructed and mechanically safe. It is evident that the type of construction and the type of materials for ordinary farm machines cannot be used in the case of the airplane.

The third important requirement is the matter of operation. There are many factors which might influence the effectiveness of the results obtained, including atmospheric conditions, width of swath covered, uniformity of application, loading, and operating speed.

There are companies and individuals who will emphasize the shortcomings of the airplane for agricultural use for personal reasons. There is also danger of authoritative evaluations that condemn its use at this stage by this or other groups. It may not be quite as effective now as some other methods, and the cost may be more than other methods, yet its use can be justified at this stage of development. The main point is, don't be disturbed if you are told that the airplane is of no practical value to the farmer, because the operating cost is greater than ground application, or that it does not do as good a job as ground methods. Only a few years ago we were told by those who kept the records that the tractor was no good and it could never compete with the horse. We were also told a very few years ago that electricity was too expensive and the farmer could not afford it. The important thing is that a need exists that cannot be satisfactorily met with existing machines. We should have all the facts to determine whether the use of the airplane is the best solution at hand.

Most people would like to accomplish one of several things when they use a new type of equipment. The job should be done either better, quicker, at less cost, produce a higher quality product, or be less dangerous than the old method used. The airplane's chief value for most operators is the saving of time. In some operations, such as seeding or when used to apply fertilizer, insecticides, or herbicides, the condition of the land or the crop may be such that a ground machine could not be used at all. The quality of the job, or the cost of the job, are not necessarily the factors that determine the practicability of its use.

There are many types of problems that must be solved to make the airplane an effective implement, many of which I have mentioned. They are not just mechanical or engineering problems. We must look, however, to the aeronautical engineers and manufacturers to modify the plane design to support attachments or auxiliary equipment in the form of sprayers, dusters, seeders, or other devices. The time may not be far distant when many planes for farm use are designed and built for a specific job.

To some it may appear that the engineering problems are the major ones, but there are problems for the plant scientist, the pathologist, the entomologist, the animal scientist, and there are problems for the lawyer. Many of the problems are being solved by industry, some by the Civil Aeronautics group, and others are being solved by custom operators who use airplanes and recognize the need for making changes. Some basic information is being supplied through the research carried on by the agricultural experiment stations, all to the end that the airplane will be an effective agricultural implement.

There are special problems that relate to the conditions under which the airplane must be used. It is evident that where there are large tracts of land, as under western conditions, the airplane can be used more effectively than in areas where farms are small. It is generally conceded that the operator of such equipment should be thoroughly trained with a lot of hours of experience. It is doubtful that the time is near at hand when flying farmers will operate their airplanes for dusting, spraying, seeding, or similar uses. In custom work the need for skill in operation, experience, a sense of timing, and good judgment makes this a job for the seasoned pilot.

It will be through the cooperation of all who are interested that the airplane will be made an effective agricultural implement. You can be assured that the agricultural experiment stations and the U. S. Department of Agriculture will devote more attention to this need and the many problems related to it as farmers and the public demand it.

This is an abstract of a paper presented at the National Agricultural Aviation Conference, Kansas City, Mo., April 21 and 22, 1949.

E. W. LEHMANN is professor and head, agricultural engineering department, University of Illinois, Urbana.

Reservoir and Pond Construction Problems

THE purpose of this report was to make available representative data on problems in farm reservoir and pond construction. The method of securing data agreed upon by the ASAE Committee on Reservoirs and Ponds was as follows: Each member of the Committee submitted a tentative questionnaire to the chairman, who was directed to make up composite questionnaires, one to be compounded by each committeeman for his respective state and one to be answered by custom operators. The method of contacting custom operators in each state was left to the discretion of each committeeman. The questionnaires obtained from contractors were summarized by the committeemen and forwarded to the chairman to form the basic part of this report in conjunction with committee questionnaires.

The states represented by the Committee activity were Georgia, Kentucky, Missouri, Ohio, Oklahoma, Pennsylvania, and Tennessee. (H. D. Ayres' report on the farm reservoir and pond program for the Canadian prairies appeared in AGRICULTURAL ENGINEERING for April, 1949.) The states having constructed the largest number of farm reservoirs are Missouri, Kentucky, and Georgia, respectively, reporting a total of 143,171 built prior to 1948.

One state reported 1 to 2 per cent of farm reservoirs constructed with farmer-owned equipment. All custom operators reported using bulldozers and a small number reported using scrapers with track-type tractors on larger jobs. Only one contractor reported using farm tractors. The primary motive given for construction was for farm use.

All contractors returning questionnaires reported they were digging core trenches down to impervious material. Not all were carrying clay above the base of the dam because earth being used in some dams contained sufficient clay.

The width commonly used for the top of the dam was 8 ft. Ninety-eight per cent reported a 3 to 1 slope on the wet side of the dam and 2 to 1 slope on the dry side.

The amount of freeboard allowed (height of dam above maximum water level) varied from 2 to 5 ft, with average of 2.5 ft. In most cases, the spillway was designed for a depth of flow of 1.0 ft or less. Georgia reported that they were requesting contractors to maintain a minimum depth of 2 ft around the entire reservoir, 3 ft from shore.

All states reported constructing earth dams rather than excavated ponds, which are a combination of excavation and earth fill as earth is taken from above the dam site to make the fill. No state reported any specifications required for relation of storage capacity to drainage area, relation of acreage in reservoir to width of dam, relation of height of dam to top width, or maximum watershed for various types and sizes of dams.

All states depended largely on careful construction, such as removing all vegetation and digging a core trench, to prevent seepage. Some used a clay blanket on the wet side of the dam, and all had used chemicals in doubtful locations.

Various reservoir protection practices are being used, such as terracing, vegetation, and fencing cattle out of the water, and installing stock water tanks below the earth dam.

Oklahoma reported the lowest cost per cubic yard for moving earth into place with bulldozers. Average cost of all contractors reporting was 8.6 c; however, these reports came from one section of the state where conditions were similar. Kentucky average was 20.5 c per cu yd. Pennsylvania 22 c, Ohio and Missouri 22.5 c. There was not a sufficient number of other types of equipment used to get a true picture.

In compiling reports, it was noted that details of construction showed little variation, indicating that field engineers, through experience, have arrived at about the same conclusions as to recommendations, and to date no research data is available to warrant any changes.

PROBLEMS REPORTED FOR DISCUSSION

1 One state reported its farm reservoir program slowed down tremendously with reduction in funds available through PMA

2 Maintenance problem: (a) proper maintenance of dams and spillways; (b) selling farmers on the idea of fencing out livestock and putting stock tanks below the dam

3 Getting farmers to allow contractors to construct larger farm reservoirs

4 Fitting the pond into the over-all farm plan

5 How to get farmers to appreciate the importance of following engineer's plans

6 How to overcome the tendency of farmers to feel that engineers are over-designing.

Report (1948-49) of the Committee on Reservoirs and Ponds, Soil and Water Division, American Society of Agricultural Engineers — John L. McKitrick, (chairman), H. D. Ayres, C. G. Burress, J. R. Carreker, M. W. Clark, J. I. Davis, Sr., W. H. Dickerson, Jr., Virgil Overholt, and C. V. Phagan.

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA NOTES ON POTATO GRADER, POTATO STORAGE, MATERIALS SURVEY, AND FLAX PULLER

Potato Grader. In cooperation with the Colorado Agricultural Experiment Station, Division of Farm Buildings and Rural Housing, USDA, has developed a potato grader for automatic separation of potatoes on the basis of specific gravity. The work is part of a Research and Marketing Act project on new methods of grading, packaging, and shipping to maintain potato quality and to determine consumer acceptance of quality. If heavier potatoes commands a premium price for their better baking qualities, it becomes important to be able to separate them efficiently from the lighter ones.

The mechanical grader worked out at the Colorado station establishes the principle of separating the grades of potatoes by means of their specific gravities as basically sound and practicable. All operations in the grader are automatic and the sorted potatoes are discharged to appropriate bags at the end of the apparatus. The new machine is designed to receive potatoes direct from an ordinary washer and grader. Essentially the specific gravity separator is a tank containing a salt solution with a density of about 1.084. Potatoes which failed to float in a brine of this density proved, by experiment, to be the most satisfactory for baking. Washing to remove the brine follows the separation.

All the potatoes are conveyed into the brine tank from the washer by a draper chain running diagonally from the bottom of the tank at the end where the potatoes enter up the length of the tank and out over the top of the other end. A divider runs the length of the tank to within a foot of each end and extends to within 6 in of the surface of the water. It keeps the heavier potatoes moving up the right half of the conveyor. The floating potatoes are guided to the left-hand side of the tank by 3 curved metal skimmers or deflectors extending 6 in down from the top of the tank. Uniform flow of the salt solution is assisted by a metal diverter which narrows the channel at the deep end. The current itself is made entirely by the draper chain as it moves over the divider board and returns under it.

From the brine tank the potatoes are run into a spray washer to remove the salt solution. With 20 fan-shaped spray nozzles an ordinary garden hose run from a city water system will build up a pressure of 40 to 50 lb and wash the potatoes satisfactorily.

In test runs, quantities of potatoes up to two bushels have been dumped into the brine tank. After each run, during which the sinkers and the floaters were sacked separately, they have been run through the machine again, the sinkers at one time and the floaters at another. In all trials, no floater potato has appeared when the sinkers have been re-run. When the floaters have been re-run, not over 5 per cent have come out as sinkers, establishing an accuracy of 96.5 to 97.5 jer cent.

The grader is an experimental machine and improvements are needed to refine its operation. One of the problems to be met is corrosion of the mechanical parts. Further work will also aim at better separation of borderline potatoes, separation into more than two densities, separation of hollow heart potatoes, and automatic regulation of brine densities in the separator.

New Potato Storage Project. Potato growers on Long Island, in eastern Pennsylvania, and in New Jersey have common problems in storing their crop. In these areas potatoes mature and are harvested early and

are in storage for several weeks before cool weather. The USDA Division of Farm Buildings and Rural Housing is cooperating with the New Jersey, New York, and Pennsylvania agricultural experiment stations in a new line project under RMA to determine the most efficient and practical types of buildings, equipment, and operating procedures for the storage of potatoes on the farm and at local shipping points under the climatic and marketing conditions in the potato-producing areas of the three states.

Three types of storages will be studied: Common underground, with thermostatically controlled ventilation; common aboveground, insulated, with controlled ventilation, and refrigerated storages. Data will be obtained on temperature of potatoes when dug, when stored, and periodically during storage; handling practices in the field and in storage; prestorage condition of potatoes with respect to injury and disease; environmental conditions within and without the storage structures; handling injuries during storage, and construction and operating costs of the storages.

Headquarters for the new project are at New Brunswick, N. J., with Richard S. Claycomb engineer in charge for BPISAE. Mr. Claycomb is a graduate of Colorado A. & M. College at Fort Collins, where he has been cooperating with S. W. McBirney of the Farm Machinery Division on sugar beet harvesting studies. Alfred D. Edgar, USDA potato storage project leader, came east from Fort Collins in July to set up the New Jersey project and confer with specialists on the potato storage work at East Grand Forks, Minn. The Red River Valley Potato Growers Assn. has built a new laboratory at East Grand Forks, and Mr. Edgar will move his headquarters there shortly.

Grain Storage Structures. Designs have been completed for a series of 30 ear corn and small grain structures ranging from a 300-bu self-feeder for hogs to 10,000-bu farm elevators. The Division of Farm Buildings and Rural Housing cooperated in this work with the Production and Marketing Administration, Bureau of Entomology and Plant Quarantine, Extension Service, and the Illinois, Iowa, Kansas and Purdue University agricultural experiment stations. The Midwest Plan Service, sponsored by the state agricultural colleges of the north central states, has just published a catalog illustrating the complete series of plans. Working drawings are available through the state extension services.

CCC Grain Storage. Wallace Ashby and E. G. Molander, farm buildings and rural housing division, USDA, to Elmer F. Kruse, manager of USDA Commodity Credit Corporation, in the awarding of contracts for the hundreds of millions of bushels of shell corn and small grain storage being purchased to handle CCC loan stocks. The Corporation invited bids for bins of any design, and over 200 bidders responded. The job of the agricultural engineers is to perform the technical review of plans and specifications to determine structural and functional adequacy.

Onion Storage. In cooperation with the Colorado Agricultural Experiment Station, the USDA division of farm buildings and rural housing is starting a new project on onion storage in Colorado's Arkansas Valley. Headquarters are at Rocky Ford, where the Arkansas Valley Branch Experiment Station is also located. The sweet Spanish onion grown in the area, a very popular market variety, is a high-moisture onion radically susceptible to disease in storage. The project will attempt to determine the best environment for curing and keeping the onions and devise means for maintaining this environment in the storage structures. Checks will be run on the quality and condition of onions entering and leaving storages and on temperature, humidity, and air movement within the structures. Agricultural engineer in charge of this work for BPISAE is Philip B. Doherty, Iowa State College graduate who has been working with the division on grain storage at Ames since July, 1948. W. C. Edmundson, BPISAE horticulturist stationed at Greeley, Colo., will be available as consultant.

Building Materials Survey. Richard L. Pillsbury of the division of farm buildings and rural housing, stationed at Purdue University, is beginning a survey of the performance of building materials in actual farm service. The project is cooperative with the North Central Region under RAM. About 100 farms in each of four states — Indiana, Nebraska, Iowa, and South Dakota — are included in the selected sample. An exhaustive schedule has been developed to record the condition of all structural parts and assemblies, types and causes of damage and failure, etc.

New Flax Puller. The USDA mechanical processing of farm products division is trying out a newly designed fiber flax puller, self-propelled and embodying several other advanced features. This work is a cooperative project with Oregon State College, Corvallis, and the Oregon Agricultural Experiment Station. Jesse E. Harmond is the engineer in charge for BPISAE.

One of a number of pieces of mechanized equipment intended to help the fiber flax industry in the Pacific Northwest compete with foreign production, the new puller is designed to handle flax at a somewhat greener stage, when it gives a better fiber yield.

Puller throats have been narrowed to cause the stalks to be pulled almost straight out without bending. More even bundles from a double tie device. Two engines are used on the machine, one to propel it and the other to operate the pulling mechanism.

New Literature

"HYDROLOGY," edited by Oscar E. Meinzer under the auspices of the National Research Council. Cloth, xi + 712 pages, 6x9 inches. Illustrated and indexed. Dover Publications (1780 Broadway, New York 19, N. Y.) $4.95.

This is the third impression, first edition, of a book originally published in 1942, as Number IX in a series of monographs on "Physics of the Earth," prepared under the direction of various committees of the National Research Council. Its 15 chapters include an "Introduction," by Oscar E. Meinzer; "Precipitation" by Merrill Bernard; Evaporation from Free Water Surfaces," by Sidney T. Harding; "Snow and Snow Surveying, and Ice," by James E. Church; "Glaciers," by Francois E. Matthes; "Lakes," by Sidney T. Harding; "Infiltration," by LeRoy K. Sherman and Geo. W. Musgrave; "Transpiration and Total Evaporation," by Charles H. Lee; "Soil Moisture," by Karl v Terzaghi and Leonard D. Baver; "Ground Water," by Oscar E. Meinzer and Leland K. Wenzel; "Runoff," by Adolf F. Meyer, Charles H. Pierce, Royal W. Davenport, Wm. G. Hoyt, LeRoy K. Sherman, Clarence S. Jarvis, and Walter B. Langbein; "Droughts," by Wm. G. Hoyt; "Physical Changes Produced by the Water of the Earth," by Wm. H. Twenhofel, Harry R. Leach, Lorenze G. Straub, Charles S. Howard, and Margaret D. Foster; "Hydrology of Limestone Terraces," by Allyn C. Swinnerton; and "Hydrology of Lava-Rock Terraces," by Harold T. Stearns.

PROCEEDINGS OF 24TH ANNUAL MEETING, NATIONAL JOINT COMMITTEE ON FERTILIZER APPLICATION, 1948. (National Fertilizer Assn., Washington, D. C.) Paper, 151 pages, 8½x11 inches. Limited circulation. No price stated. Reports of subcommittees and cooperators cover corn, small grains, flax, vegetable crops, pasture and hay, legumes, cotton, field experiments, soil fertility and plant breeding, sampling soils and plants, tobacco, farm machinery, machinery for research, and fruit trees and nuts. In addition the volume covers reports of committee organization and activities, and papers on fertilizer application in relation to horticultural science; evaluation of fertilizer practices on vegetable crops; application of nutrients to above ground parts of plants to correct deficiencies; equipment for fertilizer application; and the role of legume and non-legume cover, sod, and hay crops and their fertilization in rotations to improve soil structure and fertility.

ARC WELDING. Paper, 24 pages, 8½x11 inches. Illustrated, punched to fit standard three-ring loose-leaf binders. James F. Lincoln Arc Welding Foundation (Cleveland 1, Ohio), 25 cents.

This manual covering fundamentals of arc welding was prepared cooperatively by the Foundation and the Vocational Agriculture Service of the University of Illinois, as text material for vocational agriculture and veterans training classes in Illinois. In addition to being a class training text, it is useful as an instruction manual and handbook for all farm users of arc welding. It covers equipment needed for arc welding, learning to weld; general welding instructions; steps in making fillet, lap, butt, edge, and corner welds in all four welding positions; welding cast iron and high-carbon steel; hard surfacing and cutting; and shop exercises. It also explains different types of electrodes, their uses, differences in various types of metals, and how to recognize them.

PREVENT WIND DAMAGE, by Henry Giese. 16 pages, 6x9 inches. Iowa Mutual Tornado Insurance Assn. (Des Moines). No price stated.

Concise information on preventable causes of wind damage, the nature of winds and pressures, foundations and anchorage, walls vs. weather, studs weakened by ribband notch, joints and ties, additional braces, splicing of lumber, masonry walls, self-supporting roofs, roofing problems, fastenings, safe loads on beams, and additional wind hazards.

SAE HANDBOOK (1949 edition) cloth, 5½x8 inches. Society of Automotive Engineers (New York 18, N. Y.).

New specifications appear in this edition under the classifications of equipment, lighting, materials, parts and fittings, and tests, ratings, and nomenclature. Some which may be of particular interest to agricultural engineers cover power take-off (heavy duty), tractor and implement disk wheels, tractor hydraulic remote control, tractor rear power take-off and mounting face, and rating of power take-off. Revised specifications also appear under each of these and other headings.

HYDROLOGY, by C. O. Wisler and E. F. Brater. Cloth, 5½x8½ inches. Illustrated and indexed. John Wiley and Sons (New York); Chapman and Hall (London), $6.00.

Prepared as a college text and an engineering reference on the subject, this work covers the subject with an introduction and chapters on the hydrograph, the drainage basin, precipitation, water losses, infiltration, ground water, runoff, floods, and stream flow records.

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NEWS SECTION

ASAE Southeast Section Meets in February

THE Southeast Section of the American Society of Agricultural Engineers will hold its 1950 meeting in conjunction with the annual convention of the Association of Southern Agricultural Workers which will be held February 9, 10, and 11 at Biloxi, Mississippi. Headquarters for the convention and all meeting sessions will be at the Buena Vista Hotel. ASAE members attending the meeting are registering for guest rooms at the Tivoli Hotel.

Ga. Student Ag Engineer Wins Top Honor

THE honor of being named valedictorian of the summer University of Georgia graduating class went to James H. Anderson, Jesup, Ga., (Student Member of ASAE), who was a candidate for the degree of bachelor of science in agricultural engineering at that institution. Anderson won out over four other candidates — all with top scholastic averages — in a student election held July 28. He is a 22-year-old World War II veteran; he served in the European theater and was awarded the purple heart.

ASAE Appoints Assistant Secretary

THE headquarters office of the American Society of Agricultural Engineers announces the appointment of Cernyw K. Kline as an assistant secretary. Mr. Kline, who joined the ASAE staff on September 6, is a native of Connecticut. In the early 1930's his parents moved to a farm in Michigan which he helped to operate and put on a paying basis while attending country school, high school, and college. He entered Michigan State College on a 4-H scholarship prior to World War II, where he took vocational education, majoring in agricultural engineering. While in college he was active in the following extra-curricular activities: Secretary of the first member-owned men's cooperative house, vice-president of Alpha Zeta, vice-president of the ASAE Student Branch, president of the College YMCA, and president of Farmhouse. The war, however, disrupted his college career in his senior year.

In World War II he served as an enlisted man for 15 months and then received a commission as second lieutenant in the Quartermaster Corps. He helped train both white and colored troops for both the European and Pacific theaters. He went overseas with a motor truck company and was made battalion motor officer for one of the largest transportation pools in the Pacific area. During the last six months of his overseas service, he was Quartermaster Excess and Supply Officer for the Western Pacific Base Command. He served 43 months in the Army and was discharged with the rank of captain.

Immediately on release from war service in the fall of 1946, he enrolled in the professional agricultural engineering curriculum at Michigan State College and received his BS degree in June, 1948. He also completed a few remaining requirements of the work interrupted by war service and received a BS degree in soil science in December, 1948. He received a master's degree in agricultural engineering in June of this year.

Personals of A.S.A.E. Members

M. Conner Ahrens is now assistant agricultural engineer with the USDA Divisions of Agricultural Engineering and is engaged in research in farm refrigeration at State College of Washington, Pullman.

Alfons Alven recently resigned as president of the Bearings Company of America, to accept appointment as general sales manager of The Rollway Bearing Company, Syracuse, N. Y. Mr. Alven's entire business career has been associated with the anti-friction bearing industry, during which he has been in close contact with the farm equipment industry.

Charles G. Burress, extension agricultural engineer, Pennsylvania State College, has been appointed to take charge of the agricultural engineering work of the Division of Agricultural Extension at that institution, succeeding the late John R. Haswell.

James E. Ferguson, until recently enrolled as a graduate student in agricultural engineering at the Utah State Agricultural College, is now assistant professor of agricultural engineering at the University of Arkansas, where he will be engaged in research work in supplemental irrigation.

Herman J. Finkel has resigned as structural engineer of Consoer, Townsend, and Associates, Chicago, to accept a position in the newly formed department of soil conservation in the ministry of agriculture of the state of Israel, where he will be working on the development of an over-all soil conservation program for the country.

M. T. Gowder has been advanced from the position of assistant extension agricultural engineer, University of Tennessee, to extension rural engineer, succeeding G. E. Martin, retired.

Ernest H. Kidder recently was named associate professor of agricultural engineering at Michigan State College, where he will work in the soil and water division of the agricultural engineering department. He was formerly associate hydraulic engineer, Soil Conservation Service (Research), USDA, and was stationed at Urbana, Illinois for several years. More recently he was in charge of the SCS research program at its Auburn, Alabama, station.

Howard F. McColly has joined the staff of the agricultural engineering department at Michigan State College in the rank of professor, to work in the farm power and machinery division of the department. He recently completed his work as a member of the Committee of Agricultural Engineering, National Agricultural Research Bureau, Chinese Minister of Agriculture and Forestry. Previously he was head of the agricultural engineering department at North Dakota State College, and later chief water facilities engineer in the 17 western states for the Farm Security Administration, USDA.

Bernard P. Rines has been appointed head of the agricultural engineering department, University of New Hampshire, Durham, succeeding the late George M. Foulkrod. *(Continued on page 448)*

A.S.A.E. Meetings Calendar

September 7 to 9 — NORTH ATLANTIC SECTION, Pennsylvania State College, State College

September 26 — CHICAGO SECTION, Place to be announced.

October 6 to 8 — PACIFIC NORTHWEST SECTION, Harrison Hot Springs Hotel, Harrison Hot Springs, B. C.

October 29 — IOWA-ILLINOIS SECTION, LeClaire Hotel, Moline, Ill.

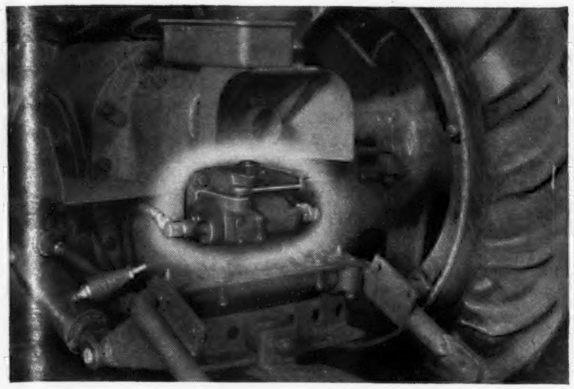
December 19 to 21 — WINTER MEETING, Stevens Hotel, Chicago, Ill.

February 9-11 — SOUTHEAST SECTION, Buena Vista Hotel, Biloxi, Miss.

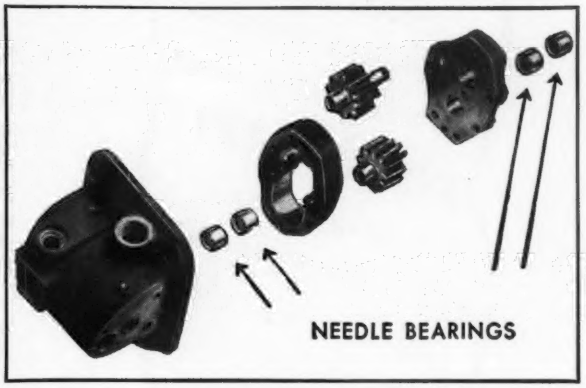
June 19-21 — ANNUAL MEETING, Statler Hotel, Washington, D. C.

Two views of press conference held during ASAE annual meeting at East Lansing in June. The "experts", left to right, are A. W. Turner, chief, agr. eng. divs., USDA; E. D. Anderson, sec'y, National Sprayer and Duster Assn.; Frank J. Zink, Frank J. Zink Associates; A. J. Schwantes, chief, ag. eng. div., University of Minnesota, and J. B. Davidson and Henry Giese, both professors of agr. engineering, Iowa State College

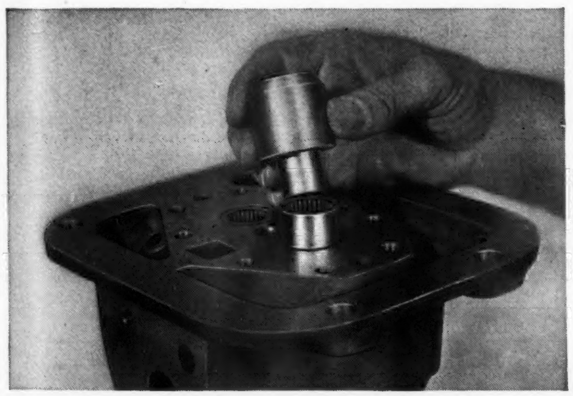
Torrington Needle Bearings Pack More Power Into Hydraulic Gear Pumps



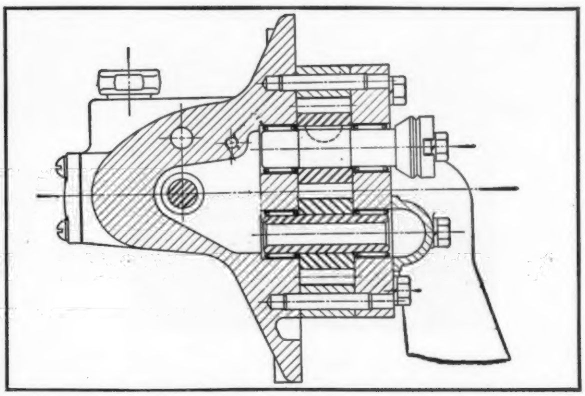
The swift-acting, powerful hydraulic control unit on J. I. Case tractors depends upon a high-efficiency, high-capacity gear pump. To maintain close internal clearances and good alignment, Case has developed an excellent design incorporating Torrington Needle Bearings.



Exploded view of the pump is shown above. Four "Precision Series" Torrington Needle Bearings provide the ultimate in internal pump clearances and match the high accuracy of the other pump parts. By reducing wear, they help assure peak mechanical efficiency and long service life.

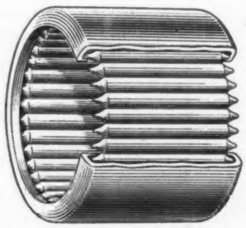


The small diameter and retaining feature of Needle Bearings simplify design and assembly. Installed by an arbor press, Needle Bearings take a firm press fit in straight-through housings, need no retaining devices. They use the hardened and ground shafts as inner races.



Cross-section of the pump shows the compact design secured. Needle Bearings permit the use of larger and stiffer shafts with short housing width, minimizing deflection. Adequate surface is provided for sealing at the ends of each gear without lowering pump efficiency.

In designing gear pumps for automotive, aircraft, farm, construction and industrial equipment, use Needle Bearings to secure the best features of pump design. Our engineers will gladly assist you in analysis of designs and bearing recommendations. Write us today. The Torrington Company, Torrington, Conn., or South Bend 21, Ind. District offices and distributors in principal cities of United States and Canada.

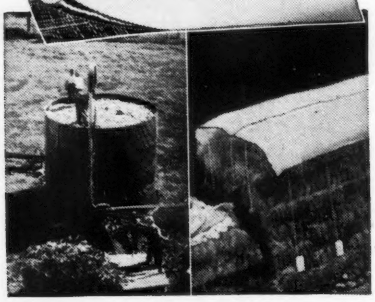


TORRINGTON *NEEDLE* BEARINGS

Needle • Spherical Roller • Tapered Roller   Straight Roller • Ball • Needle Rollers

AS ADVERTISED IN
COUNTRY GENTLEMAN
SUCCESSFUL FARMING
PROGRESSIVE FARMER
HOARD'S DAIRYMAN
AND OTHER FARM MAGAZINES
SISALKRAFT
IS WORTHY OF
YOUR ENDORSEMENT
FOR THIS AND MANY
OTHER FARM USES

KEEP FODDER SAFE *with*
SISALKRAFT SILOS
AND HAYSTACK COVERS



Thousands of tons of fodder are saved annually by farmers who take advantage of tough, waterproof, windproof SISALKRAFT. You can build and fill a SISALKRAFT Corn or Grass Silo in a day. It's simple, low cost, safe! And SISALKRAFT haystack covers give barn-like protection to field-stacked hay (baled or bulk) . . . saving you lots of labor, time and money . . . preserving the feed value of the hay by protecting it from destructive rains and scorching sun. For more and better fodder at low cost, SISALKRAFT is your answer.

MAIL THIS TODAY!
The SISALKRAFT Co., Dept. AE-7
205 W. Wacker Drive, Chicago 6, Ill.
Please send samples and more facts about SISALKRAFT on the farm.
Name..........
Town..........
RFD No.......... State..........

Ask your Lumber Dealer to explain ALL the uses of SISALKRAFT on the farm

The SISALKRAFT Co.
205 W. Wacker Drive, Chicago 6, Ill.

Necrology

John R. Haswell, professor in charge of agricultural engineering extension, Pennsylvania State College, passed away July 30 at University Hospital, Philadelphia, Pa., following a brief illness and an emergency operation for a brain tumor.

Mr. Haswell was born at Baltimore, Md., in 1886; graduated in engineering from Baltimore Polytechnic Institute in 1906; and received his professional degree of civil engineer at Cornell University in 1909. After beginning engineering work with the U. S. Geological Survey and the Pennsylvania Railroad, he was appointed assistant drainage engineer in the U. S. Department of Agriculture in April, 1910. With the exception of a period from 1917 to 1919 when he saw service in World War I, as a captain in the Corps of Engineers, U. S. Army, he continued in drainage work with the USDA until March, 1920, with promotions to senior drainage engineer. Since them he had been in the agricultural extension service of Pennsylvania State College. He was widely known for his effective extension work in drainage, rural sanitation, farm buildings, and rural electrification. He was a Fellow in the American Society of Agricultural Engineers, having first become a member in 1920. He served as chairman of the Society's North Atlantic Section in 1933, was active in the Society's committee work, and was one of its most regular members in attendance at meetings. During this year's annual meeting at East Lansing, Michigan, he contributed substantially to the program and exhibits of the Committee on Extension.

He was also a registered professional engineer in Pennsylvania, an associate member of the American Society of Civil Engineers, a member of th Centre County Engineers Society, the Society of the First Division, AEF, the "Tuscania" Survivors, Sigma Xi, Epsilon Sigma Phi, Presbyterian Church, Masons, Shriners, American Legion, and Centre Hills Country Club.

He is survived by his widow, Mrs. Marion Paschall Frederick Haswell. Interment was at Wilmington, Del., August 1st.

Personals of A.S.A.E. Members

(Continued from page 446)

John J. McDow, until recently a graduate assistant in the agricultural engineering department of Michigan State College, has recently accepted appointment as instructor on the agricultural engineering staff of Oklahoma A. & M. College at Stillwater. He will engage in teaching and research work in the field of farm power and machinery.

Loy L. Sammet, until recently associate in agricultural engineering at Purdue University, is now on the staff of the division of agricultural economics, University of California, Berkeley, where he will be working full time on a marketing research problem, in connection with which he will be concerned primarily with the engineering aspects. The initial problem in connection with his work will be the study of packing house operations.

S. K. Sethi has been promoted from senior sales and service engineer, Marshall, Sons & Co. (India), Ltd., of Calcutta, to chief agricultural officer for the company, in which position he will be in charge of the agricultural division of the company for the whole of India.

Principals at the banquet given by Detroit industry to ASAE members attending 1949 annual meeting at Michigan State College. Left to right: H. B. Walker, professor of agricultural engineering, University of California; J. C. Cahill, toastmaster and chairman, ASAE Michigan Section, and Chas. F. Kettering, president, General Motors Research Corp. Walker and Kettering were the banquet speakers

Crops can be allergic, too

Farmers are only too well aware that crops are "allergic" to moisture and changes in the weather unless properly dried and safely stored.

That's why more and more farmers are finding that the mechanical drying of crops helps them make more money. Don't hesitate to tell them that dryers with combustion chambers made of Armco Stainless or Armco ALUMINIZED Steel operate more efficiently and last longer. Both metals resist heat and rust, and conserve fuel because they reflect heat better.

Many manufacturers know that storage bins made of Armco ZINCGRIP-PAINTGRIP make another good investment to keep the farmer's crops sound and salable. They like this special zinc-coated steel because it gives lasting rust-protection, and because it is especially prepared to hold paint a long time and remain attractive for years.

More and more farm families are buying indoor and outdoor products made of Armco Special-Purpose Steels—including bright, rustless Armco Stainless Steel for dairy equipment and other uses. The manufacturers who use these steels in their products are giving purchasers extra years of wear and dependability.

The Armco trademark means "top metal quality" designed to do a particular job well. So make it a point to look for this famous trademark.

ARMCO STEEL CORPORATION

HEADQUARTERS AT MIDDLETOWN, OHIO, WITH PLANTS AND SALES OFFICES FROM COAST TO COAST • THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE

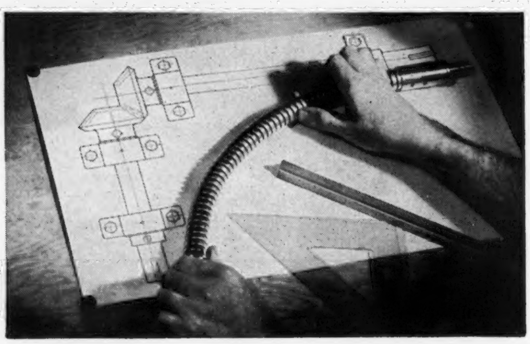
ARMCO

Design Engineers!

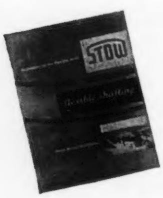
Power Transmission Problems

SOLVED SIMPLY

WITH STOW Flexible Shafts



- **STOW FLEXIBLE SHAFTS** simplify intricate power transmission problems by eliminating complex gearing with its close tolerance and alignment difficulties.
- **STOW FLEXIBLE SHAFTS** provide savings . . . increase design efficiency and eliminate hazards of exposed shaft assemblies.
- **WRITE TODAY FOR YOUR COPY of STOW'S NEW BOOK on FLEXIBLE SHAFTING** (included in Sweet's 1949 File for Production Designers).



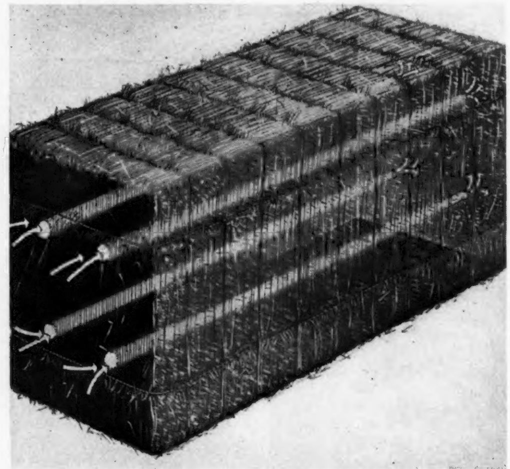
LEARN HOW STOW FLEXIBLE SHAFTS HAVE BEEN SOLVING POWER TRANSMISSION PROBLEMS SINCE 1875.

STOW MANUFACTURING CO.
39 SHEAR ST. BINGHAMTON, N. Y.

NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

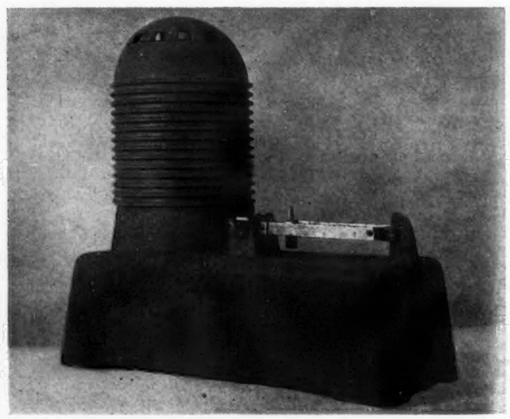
The Case Ventilated Bale is a new development by J. I. Case Co., Racine, Wis., and is the product of eight years of research and development work. The company claims that the ventilated bale, being more porous, gives opportunity for the hay to dry out properly and thus reduce the possibility of mold growth. Tests on this new bale conducted at Michigan State College show that the ventilated bales, after being in storage for several weeks and then removed for grading along with standard bales, were consistently graded higher than the standard. The increased porosity is accomplished by an inexpensive device which perforates the bale as it is being made.



A J. I. Case ventilated bale

• • •

The New American All-Crop Moisture Tester (American Crop Drying Equipment Co., Crystal Lake, Ill.) provides for infrared drying and fan removal of moisture from a weighed sample on a delicate balance. By providing for starting with a uniform sample weight, the weight loss in drying can be read directly on the scale beam as a percentage of the sample weight, or per cent moisture (wet basis) in the item sampled. The apparatus measures 18x7x14 inches, and is being sold through dealers at $57.50.



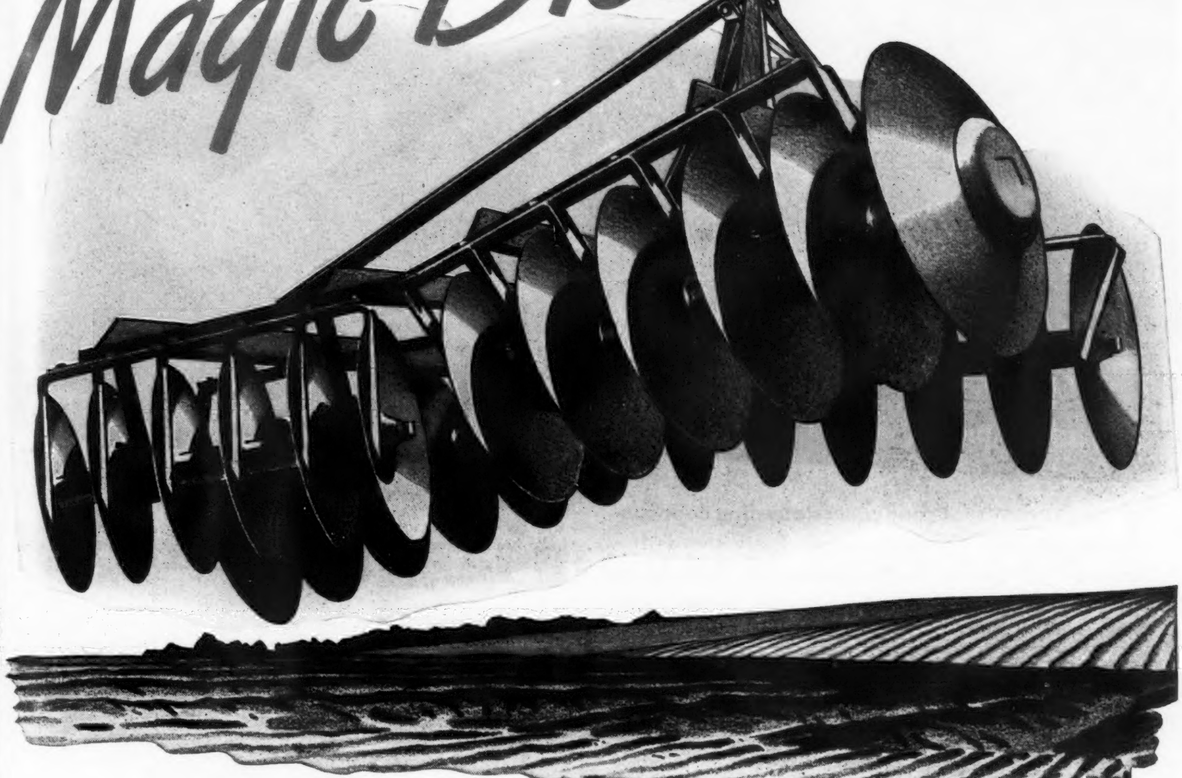
The American All-Crop moisture tester

• • •

"The Zinc Industry — A Mine to Market Outline" is the title of a new 6x9-inch bulletin of 62 pages published by the American Zinc Institute, 35 E. Wacker Drive, Chicago, 1, Ill. It pictures the nature and early history of zinc, the amount of zinc used, principal uses, production, by-products, and marketing.

(Continued on page 452)

THE *Magic Disc*



or the case of the Tandem Disc Harrow that got "lifted"

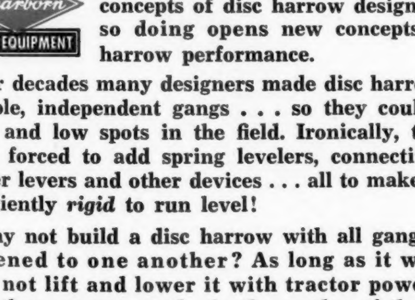
Dearborn FARM EQUIPMENT

The Dearborn Tandem *Lift Type* Disc Harrow goes beyond many established concepts of disc harrow design, and by so doing opens new concepts of disc harrow performance.

For decades many designers made disc harrows with flexible, independent gangs . . . so they could follow high and low spots in the field. Ironically, they also were forced to add spring levelers, connecting links, center levers and other devices . . . all to make the disc sufficiently *rigid* to run level!

Why not build a disc harrow with all gangs rigidly fastened to one another? As long as it was rigid, why not lift and lower it with tractor power? Why not, then, permanently *fix* the angles of the gangs?

COPYRIGHT 1949, DEARBORN MOTORS CORPORATION



This Dearborn Disc Harrow has all these features. The farmer can lift it with the Ford Tractor's Hydraulic Touch Control lever to get to and from the field, thereby avoiding blade damage and wear.

Because angles are fixed he gets maximum pulverization not only in deep but also in *shallow* work. When he strikes a high spot it gets leveled *fast* since the weight of all gangs rests on the three or four blades that strike it!

To receive additional information on this fascinating story, write to us direct, or ask your nearest Ford Tractor dealer to demonstrate for you the many interesting features of the Ford Tractor and the Dearborn Farm Equipment engineered for it.

DEARBORN MOTORS CORPORATION • DETROIT 3, MICHIGAN

Ford Farming

MEANS LESS WORK . . .
MORE INCOME PER ACRE

Engineered feeding floors require

QUALITY CONCRETE

and care in placing, finishing and curing

THE PRINCIPLES of good concrete feeding floor construction are simple but vital. Every step is important—the quality of aggregates, amount of water used, proportioning, mixing, placing, finishing and proper curing. Strict observance of the principles of quality concrete construction will insure thrifty, long-lasting feeding floors.

Do you know, for instance, how much water should be added per sack of cement for a durable feeding floor if sand is in an average moist condition?* Or, how soon after the concrete has been leveled with a strikeboard you can use a wood float for finishing?†

"*Design and Control of Concrete Mixtures,*" a free, 70-page booklet, answers dozens of questions about quality concrete. This booklet will be helpful in designing concrete for any farm purpose. Write today for your copy. Distributed only in the United States and Canada.

Remember, whether you are designing a barn foundation or floor, poultry house, driveway, milk house, granary, feeding floor or any other farm improvement, you can be sure of quality concrete by following time-tested methods of control. A good job builds your reputation as a quality engineer and improves farms with feed-saving, labor-saving, money-saving construction.

*Answer: Not more than 5 gal. water.

†Answer: Not until all water sheen has disappeared from surface and concrete begins to harden.

PORTLAND CEMENT ASSOCIATION

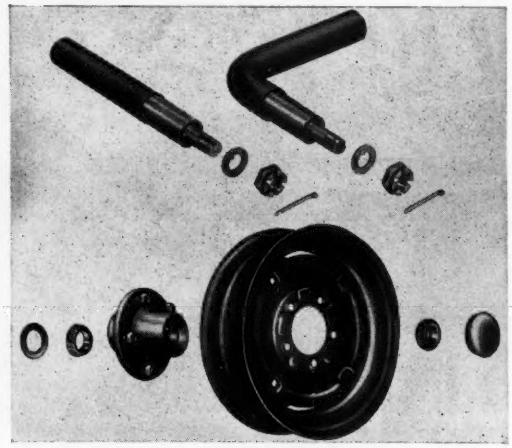
Dept. A9-1, 33 W. Grand Ave., Chicago 10, Ill.

A national organization to improve and extend the uses of portland cement and concrete...through scientific research and engineering field work

News from Advertisers

(Continued from page 450)

French & Hecht drop-center, disk wheels — in light, medium and heavy-duty range — constitutes a new line of wheels just brought out by French & Hecht Div., Kelsey-Hayes Wheel Co., Davenport, Iowa. They offer modern and safe wheel mounting for wagons, trailers, scoops, sprayers, and many other forms of conveyance and portable equipment,

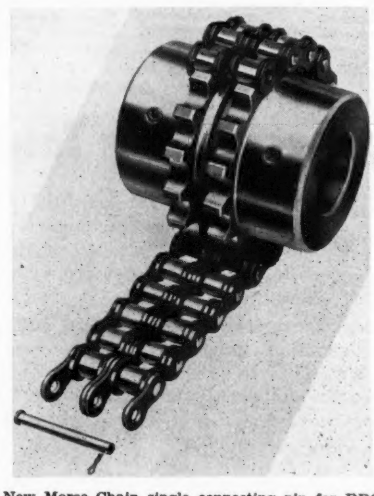


French & Hecht drop-center disk wheel

and are sold as a group (kit or unit) comprising the rim and disk, hub, bearing cones, grease seal and cap — with or without brakes (brakes being available in certain heavy-duty sizes only) — and with bent or straight spindles.

• • •

Morse Chain Company, Division of Borg-Warner Corp., announces the adoption of a new single connecting pin design for their series DRC, stock double roller chain couplings. The single connecting pin design increases the ease with which roller chain couplings can be assembled or disassembled. Morse DRC roller chain couplings are made



New Morse Chain single connecting pin for DRC double roller chain couplings

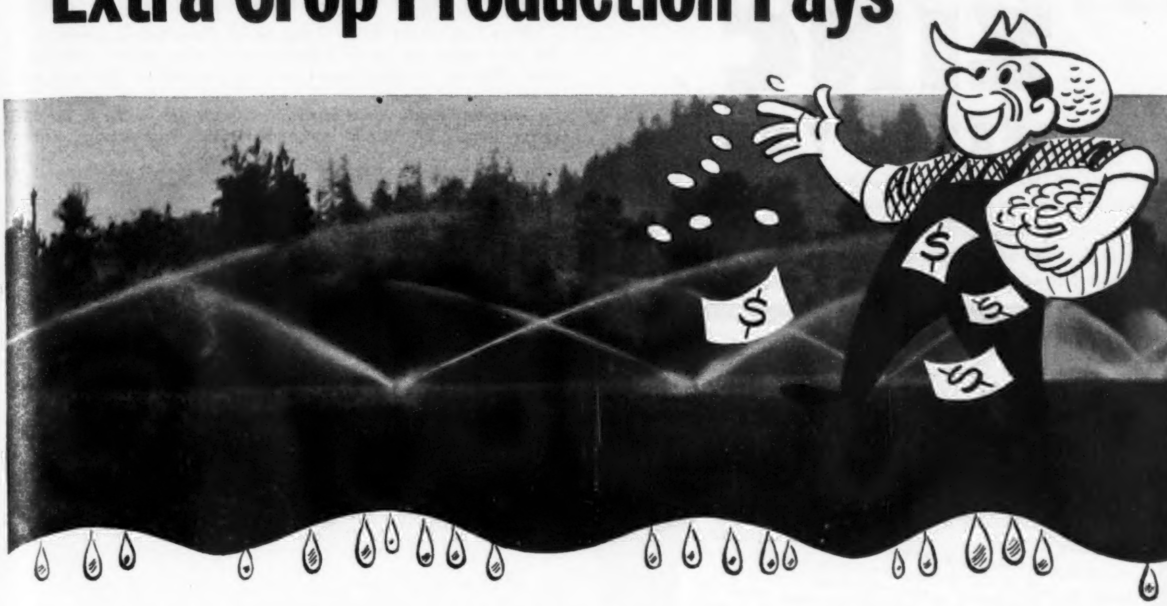
in 7 sizes ranging in capacity from 2.7 to 97.0 hp per 100 rpm and are carried in stock with a wide range of finished bores. For complete engineering data write for catalog C45-49—Morse Chain, Co., 7601 Central Ave., Detroit 8, Michigan.

• • •

Johns-Manville "Farm Handbook and Building Reference Guide". Priced at $1.50 per copy, this new book has been produced by Johns-Manville, 22 E. 40th Street, New York 16, N. Y., and contains basic information about farm building problems, prepared primarily for building material dealers and their builders and contractors. Johns-Manville also is issuing especially for dealers a farm building plan service book containing 19 different farm buildings priced at $6.00. The three-part J-M dealer program also includes a bi-monthly, 24-page rotogravure magazine distributed to farmers through J-M dealers.

(Continued on page 454)

Extra Crop Production Pays



FOR PORTABLE SPRINKLER IRRIGATION

WITH REYNOLDS ALUMINUM RIGID PIPE

This farm improvement pays its own way—portable sprinkler irrigation is more economical than ever with Reynolds Aluminum Rigid Irrigation Pipe. Use less water, save time, reduce labor, water more acreage faster with this modern method of irrigation.

Crop production can be doubled—bigger cannery crops, bush crops, orchard harvests, garden truck, potatoes, tobacco, grain, hay, pasture—and quality is far better.

Plan Reynolds Aluminum Rigid Irrigation Pipe for your portable sprinkler system. It can't rust! This aluminum alloy is strong, long-lasting—won't damage in rough handling through long years of service; perfectly round for quick coupling; smooth for free flow of water under high pressure; so light one man can carry two 20-foot sections with ease. Get top production! Check your irrigation equipment dealer. He knows your local problems. He'll supply Reynolds Aluminum Rigid Irrigation Pipe.

REYNOLDS METALS COMPANY
Aluminum Division
2544 South Third Street, Louisville 1, Ky.
Please send me illustrated folder describing aluminum irrigation pipe and its application.

Name______________________________
Address____________________________
City__________________State__________

IF YOU SEE RUST... YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

REYNOLDS
***Lifetime* ALUMINUM**

CONSIDER ALUMINUM • CONSULT REYNOLDS • THE COMPLETE ALUMINUM SERVICE

here's how

ZINC

SERVES YOU

Galvanizing (Zinc-Coating) guards the farm . . . protects property . . . saves money. For as long as iron or steel is coated with Zinc, *it cannot rust!* Heavier coatings give longer protection. So for long-time, low-cost service, choose galvanized building materials and equipment . . . "Sealed-in-Zinc" against rust.

FREE BOOKLETS

Fully illustrated and packed with practical information on galvanized sheets and Metallic Zinc Paint. Send for these *free* booklets, *today!*

AMERICAN ZINC INSTITUTE
35 East Wacker Drive, Chicago 1, Ill. Rm. 2602

Send me without cost or obligation the illustrated booklets I have checked.

☐ Repair Manual on Galvanized Roofing and Siding
☐ Facts about Galvanized Sheets
☐ Use of Metallic Zinc Paint to Protect Metal Surfaces

Name________________________

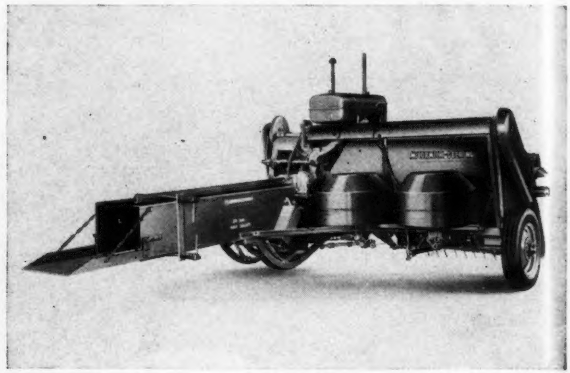
Address______________________

Town______________ State________

News from Advertisers

(Continued from page 452)

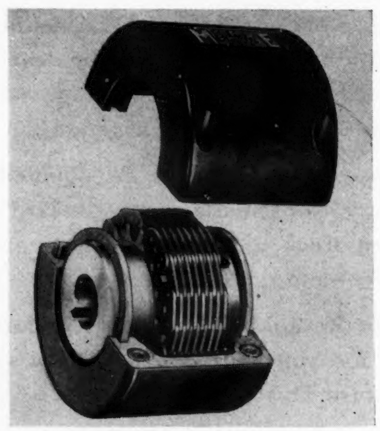
Wire-Type Pickup Baler (International Harvester) is similar to the No. 50-T except for the tying mechanism, needles, and the wire supply cans which are mounted behind the feeder as shown. This new baler is intended for hay growers who want firmer and more compact bales for shipping. Specifications of the No. 50-AW are similar to the 50-T except that the No. 50-AW is equipped with a wire twisting mechanism in which the twister hook makes three complete revolutions to form the tie. The needles are of different design and function differently from those of the No. 50-T, and the wire supply cans are mounted behind the feeder. This machine will be in limited production in 1949.



International Harvester wire-type pickup baler

• • •

Morse Chain Co., Division of Borg-Warner Corp., Detroit, Mich., announce plastic covers for chain couplings as a recent development. The new covers are molded of rag-filled phenolic plastic for maximum strength with minimum weight. The plastic material used is highly resistant to practically all acids and alkalies and is immune to rust.



Morse chain coupling with plastic cover

The covers are streamlined for safety and provide sealed-in lubrication and maximum protection. The two-piece construction with slot-head screws, requiring only an ordinary screwdriver, permits easy installation after the coupling has been completely installed.

• • •

Morse Chain Co., Div. of Borg-Warner Corp., is now offering a new 16-page catalog on flexible chain couplings. Subjects covered are roller chain stock couplings; silent chain stock couplings; heavy duty, made-to-order silent chain couplings, and steel and plastic covers for the two stock couplings. Complete information is given on dimension data, horsepower ratings, stock and maximum bores with many illustrations and useful descriptive matter. For copy of catalog C45-49, write Morse Chain Co., 7601 Central, Detroit 8, Mich.

A NEW FORAGE HARVESTER

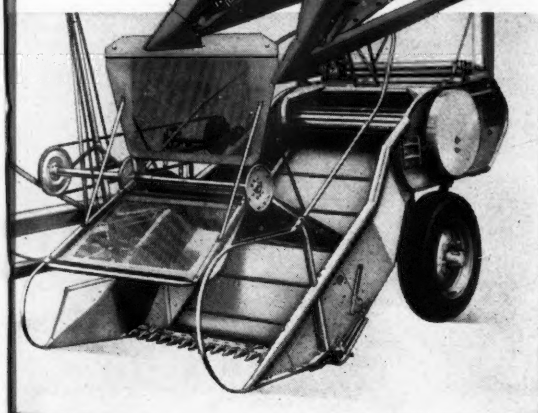
with 3 in 1 utility

1. ROW CROP HARVESTER—for corn, sorghums, and other silage crops.

The Allis-Chalmers 3-in-1 Forage Harvester consists of a base machine and three attachments, designed to handle row crops, grass crops for silage, green or cured windrows. The machine can be purchased with any one or all three attachments.

Considered as a whole, forage handling adds up to one of the heaviest jobs on the farm. Few machines offer so much to the farmer as this versatile Forage Harvester. It saves time, crop value, and hard, disagreeable work. Few machines are more worthy of individual home ownership.

Greater livestock production ... better balanced rations ... more land in soil-saving sod ... are long-time trends on family size farms that can be hastened by the use of this 3-in-1 machine.

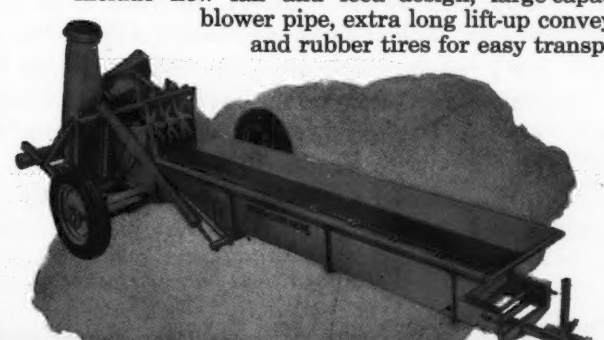


2. DIRECT-CUT HARVESTER—with sickle, reel and conveyor for handling green grass crops for silage. Saves dry grass and stalks for bedding.

... and

A NEW FORAGE BLOWER

Built to match the capacity and convenience of the Forage Harvester. Handles all forages from grass silage to long, chopped dry or wilted hay. Features include new fan and feed design, large-capacity blower pipe, extra long lift-up conveyor, and rubber tires for easy transport.



3. WINDROW HARVESTER—pick up unit for hay and straw. Also converts windrowed roughage and stalks into bedding.

ALLIS-CHALMERS

TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Bachman, David H. — 502 West Illinois, Urbana, Ill.

Bakes, Perry R. — Farm representative, Washington Water Power Co., Pullman, Wash. (Mail) 1704 Ritchie.

Bryan, John T. — Rural service engineer, Alabama Power Co. (Mail) Roanoke, Ala.

Campbell, Albert F. — Division manager (Chicago), The Timken Roller Bearing Co. (Mail) 2534 S. Michigan Ave., Chicago 16, Ill.

Cannavo, Benjamin T. — R.R. 1, Wiley Rd., Pennsgrove, N. J.

Chavous, George L. — Research assistant in agricultural engineering, University of Georgia, Athens, Ga. (Mail) Box 583, Ag Hill Center.

Coleman, Joseph L. — Field engineer, Massey-Harris Co., Ltd., Toronto, Ont., Canada (Mail) 392 Bartlett Ave.

Cook, Randolph D. — Instructor in agricultural engineering, University of Tennessee, Knoxville, Tenn.

Darby, Harry — Chairman of the board, The Darby Corp., 1st and Walker Ave., Kansas City 15, Kans.

Eakin, W. Everett — In charge of farm structures window research, Libbey-Owens-Ford Glass Co., Nicholas Bldg., Toledo 3, Ohio.

Felsing, Urban S. — Manager, Coastal Truck and Equipment Co., Box 566, Belle Glade, Fla.

Flanagan, Jeff E. — Agricultural engineer, Office of Foreign Agricultural Relations, USDA (Mail) American Embassy, San Salvador, El Salvador, C. A.

Fox, Arthur G., Jr. — Instructor in agricultural engineering, University of New Hampshire, Durham, N. H. (Mail) Pettee Hall.

Furbee, G. W. — Service engineer trainee, John Deere Plow Co. (Mail) Wenona, N. C.

Ginn, Olin W. — Division rural engineer, Georgia Power Co., Macon, Ga.

Glass, Charles D. — Farm representative, Gulf States Utilities Co., Beaumont, Tex. (Mail) 2452 Calder.

Gregg, Ralph G. — Salesman, Behling Electric Co., Guelph, Ont., Canada (Mail) 220 Oxford St.

Hiddleston, W. M. — Trainee (sales), Allis-Chalmers Mfg. Co. (Mail) Apt. 326-B, E. Boeing St., Oklahoma City 10, Okla.

Hynds, L. O. — Supervisor of product promotion, Dearborn Motors Corp., Detroit, Mich. (Mail) 19915 Monte Vista.

Keskitalo, Howard O. — Agricultural engineer, Babson Bros. Co. (Mail) c/o Surge Stores, Inc., 114 Buchanan St., Belvidere, Ill.

Kiper, James P. — Trainee, Louisiana Power and Light Co. (Mail) Chase, La.

LaRue, Robert D. — 329 Read St., Moscow, Idaho.

Levin, Jordan H. — Associate agricultural engineer (BPISAE), USDA. (Mail) Agricultural Engineering Dept., Michigan State College, East Lansing, Mich.

McArthur, Duncan — Senior extension instructor in agricultural engineering, West of Scotland Agricultural College (Mail) Elm Bank, Johnstone, Renfrewshire, Scotland.

McCoy, Wyn E. — Field engineer, The Timken Roller Bearing Co., 2535 S. Michigan Ave., Chicago, Ill.

McCraney, Roy J. — Research assistant in agricultural engineering, University of Georgia, Athens, Ga.

McNully, Allen C. — Trainee, Sears, Roebuck & Co. (Mail) R.R. 1, Linden, Pa.

McLean, Merton E. — Trainee, Allis-Chalmers Mfg. Co., Milwaukee, Wis. (Mail) 1228 N. 32nd St.

Moss, Earl L. — Agricultural engineer, Soil Conservation Service, USDA. (Mail) 30[illegible] S. Pearl, McLeansboro, Ill.

Myers, Victor I. — Agricultural engineer, Soil Conservation Service, USDA. (Mail) Box 581, Lewiston, Idaho.

O'Neill, M. J. — Sales manager, tractor and farm equipment dept., international div., Ford Motor Co. (Mail) 11514 St. Marys Ave., Detroit 27, Mich.

Ponder, Dan A. — Engineering dept., J. I. Case Co., Racine, Wis. (Mail) 2048 Thurston Ave.

Rank, Francis J. — Student engineer, New Holland Machine Div., The Sperry Corp., New Holland, Pa.

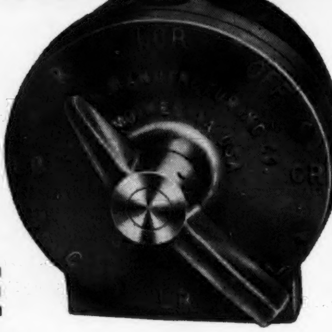
F Rothe, Juan — Agronomic advisor, Instituto de Fomento de la Produccion, Guatemala City, Guatemala, (Mail) 7a Calle Ciudad Vieja, Colonia Reforma No. 8.

Rowe, Robert R. — Industrial research division, Doane Agricultural Service, 5144 Delmar St., St. Louis 8, Mo.

(Continued on page 458)

DELAVAN... SELECT • A • SPRAY

MASTER CONTROL for FARM SPRAYERS



LOW PRICED 8-WAY VALVE

GIVES OPERATOR COMPLETE CONTROL OF SPRAY

● Specify Select-A-Spray for your 1950 sprayer design. Select-A-Spray mounts on tractor within easy reach of operator; controls the spray in left, right and center boom sections. Bronze castings resist corrosion; disc-type valve assures tight seal; ample flow to handle 30 nozzles. Select-A-Spray is guaranteed to work perfectly with your spray equipment.

Write for Prices and Literature

DELAVAN MANUFACTURING CO.

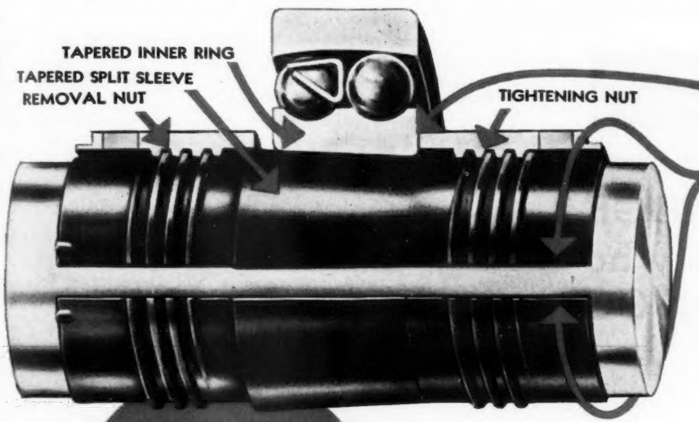
3009 SIXTH AVENUE

DES MOINES 13, IOWA

SOMETHING NEW!

SKF introduces the SUA UNIT PILLOW BLOCK featuring a tight fit between bearing and shaft

Here's How It Works



TIGHT FIT results when the tightening nut pushes the tapered inner ring over the tapered split sleeve.

CONCENTRIC GRIP is firm and positive—as the split sleeve contracts and wraps around the shaft. Removal is accomplished by reversing the process—with tightening nut loosened, removal nut pushes inner ring off the sleeve.

ON or OFF *in a few seconds*

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No exposed bearing . . . no lock screws to raise troublesome burrs on the shaft . . . the nut is locked to the sleeve . . . and even though the shaft vibrates, the concentric grip will not loosen.

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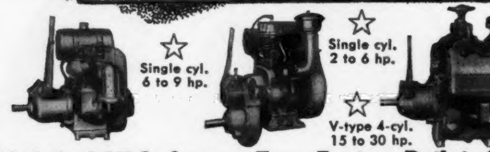

40.2% of All Carburetor Type Engines Built in 1947, 2 to 30 hp. Were WISCONSIN Heavy-Duty *Air-Cooled* ENGINES!

And here's the ALL STAR lineup . . . released in an official bulletin of the Bureau of Census, U. S. Dept., of Commerce, April 22, 1949.

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(Continued from page 456)

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Morris, Richard E. — Agricultural engineer, A. M. Todd Co., Kalamazoo, Mich. (Mail) 617 Pearl St. (Junior Member to Member)

New Federal and State Bulletins

Controlling Submersed Water Weeds on Irrigation Systems with Aromatic Solvents, by J. M. Shaw and F. L. Timmons. Laboratory Report No. CH-97 (April 1, 1949). This is a joint report by the Bureau of Reclamation, U. S. Department of the Interior, and the Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C.

The effectiveness of aromatic solvents in this use is reported to have been first discovered in 1947. More than 100,000 gallons were used in 1948 with generally satisfactory results, and experimental work was carried on at the same time. The petroleum or coal tar base solvents, which have been called naphthas, are more accurately described in terms of flash point (not less than 80 F), A.S.T.M. D-86 distillation range, and A.S.T.M. D-875 per cent aromatics (not less than 85 or 75 for the two separate types used). Oil-soluable petroleum sulfonate emulsifying agent is added (5 per cent by volume.). The report further covers briefly concentrations, time of application, water temperature, equipment, preparation for treatment, calibration of spray equipment, application, effects on water weeds, toxicity to crop plants, effect on animal life, and sources of materials for aromatic solvent treatments.

The Boiling-in-Water Method of Treating Southern Pine Fence Posts, by H. D. White, and R. D. Dixon, Bulletin 958 (February 1949), University of Georgia, Athens. Brief practical information on procedure recommended as a result of research.